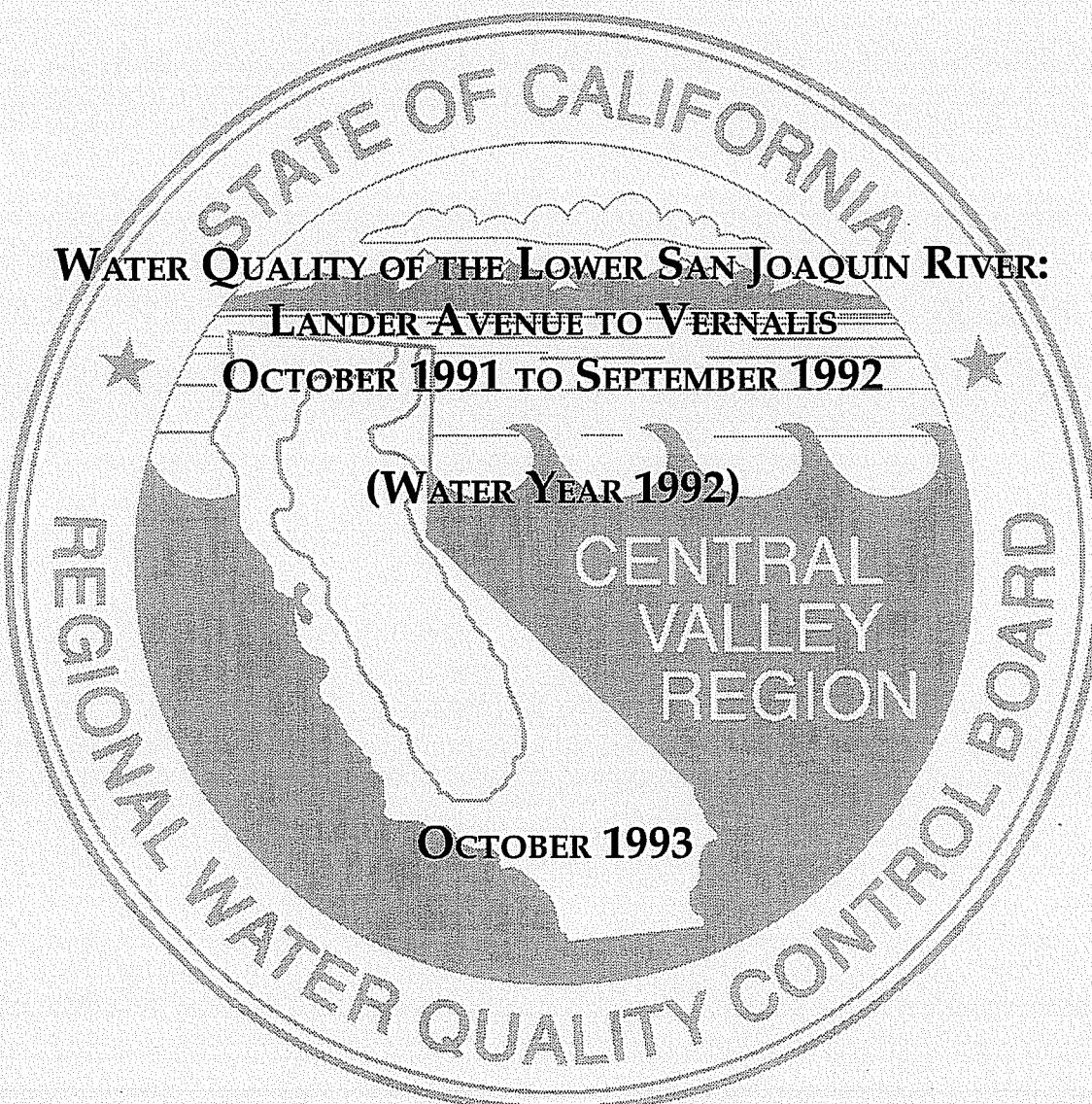


Staff Report of the
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION



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TABLE OF CONTENTS

	<u>Page</u>
SUMMARY	1
INTRODUCTION	3
STUDY AREA	3
TEMPORAL VARIATIONS AND STREAMFLOW	7
METHODS	7
RESULTS	7
CROWS LANDING SAMPLING FREQUENCY STUDY	16
DISCUSSION	16
BORON AND SELENIUM.	16
OTHER ELEMENTS OF CONCERN.	22
REFERENCES.	23

APPENDIX

	<u>Page</u>
Mineral and Trace Element Data for the Lower San Joaquin River.	24

LIST OF TABLES

<u>TABLE</u>	<u>Page</u>
1. Tributaries and Drains to the San Joaquin River Between Monitoring Stations: Lander Avenue and Airport Way	6
2. Quality Assurance Tolerance Guidelines	8
3. Water Quality Objectives as Adopted by the Central Valley Regional Board for the San Joaquin River Basin (5C)	9
4. Summary of WY 92 Monthly Mean Selenium Values	10
5. Summary of WY 92 Monthly Mean Boron Values	10
6. Ranges of Selenium and Molybdenum Concentrations by Water Year Type for Monitoring Sites Along the Lower San Joaquin River (WYs 1985-1992)	11
7. Ranges of Electrical Conductivity and Boron Concentration by Water Year Type for Monitoring Sites Along the Lower San Joaquin River (WYs 1985-1992)	13
8. Comparison of Weekly and Daily WY 92 Crows Landing Data.	17
9. Number of Exceedances of Selenium and Boron Standards (WY 1987-1992). . .	18
10. Total Recoverable vs. Dissolved Trace Elements for the Hills Ferry Site.	22

<u>FIGURE</u>	<u>Page</u>
1. Location Map	4
2. Site Index Map	5
3. Median Boron Values for WYs 1987-1992	19
4. Median Selenium Values for WYs 1987-1992	19
5. Monthly Mean Boron Concentration in the San Joaquin River at Crows Landing .	20

LIST OF FIGURES (continued)

- | | | |
|----|---|----|
| 6. | Monthly Mean Selenium Concentration in the San Joaquin River
at Crows Landing. | 20 |
| 7. | Monthly Mean Selenium Concentration at Three Sites on the San Joaquin River . | 21 |
| 8. | Monthly Mean Boron Concentration at Three Sites on the San Joaquin River . . | 21 |

SUMMARY

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. The objectives of this monitoring program are:

1. to assess existing water quality conditions and compliance with San Joaquin River Basin Plan (State Water Resources Control Board, 1989) objectives;
2. to provide a long-term database for assessing the effects of future regulatory actions;
3. to provide a database, which combined with in-stream biotoxicity data being collected by Regional Board staff, will allow assessment of potential long-term aquatic ecosystem impacts; and
4. to provide a database to validate the San Joaquin River Input-Output Model (SJRI0) described in Appendix C of the State Water Resources Control Board (SWRCB) Order No. WQ 85-1 Technical Committee Report on "*Regulation of Agricultural Drainage to the San Joaquin River*" which was released in August 1987.

Selected mineral and trace element constituents were measured for total recoverable concentrations at eight monitoring sites along a 60-mile section of the San Joaquin River extending from near Stevenson at Lander Avenue to near Vernalis at Airport Way. Water quality samples were collected weekly at eight sites. Samples were analyzed for electrical conductivity (EC), boron, selenium, temperature, and pH weekly. All samples were analyzed for chloride, sulfate, and hardness monthly. Selected sites were also analyzed for molybdenum, copper, chromium, lead, nickel, and zinc on a monthly basis. Previous reports have been issued for data collected from May 1985 through September 1991. The present report covers Water Year (WY) 1992 (1 October 1991 to 30 September 1992), the sixth consecutive critically dry year.

The general trend in constituent concentrations along the San Joaquin River study area during WY 92 continues to be that the lowest concentrations of measured constituents occur at the upstream ("background") and downstream (southern Delta boundary) study end points: Lander Avenue and Airport Way (Vernalis), respectively. Concentrations were highest just downstream of Lander Avenue below the Salt Slough and Mud Slough (north) confluences at Fremont Ford and Hills Ferry Road, respectively. Salt Slough and Mud Slough (north) are the two major sources of subsurface agricultural drainage to the San Joaquin River. Downstream of the Hills Ferry Road site, concentrations decreased as each of the three east side rivers provided dilution water for the San Joaquin River.

In December 1988, the Regional Board adopted water quality objectives for the San Joaquin River. Objectives were set for molybdenum, boron and selenium. These objectives and associated compliance dates were approved by the State Water Resources Control Board in September 1989, the final month of WY 89. Compliance with objectives was to be achieved through implementation of Best Management Practices on farm in order to reduce drainage flows and loads of the constituents of concern.

A trend analysis of boron and selenium concentrations at the Hills Ferry and Crows Landing sites indicates that drainage load reductions have been more successful in reducing downstream selenium concentrations than boron concentrations. Other management strategies, besides drainage reduction, may be required to meet boron objectives.

Molybdenum water quality objectives are delineated by location on the river: upstream of the Merced River inflow ($19 \mu\text{g/L}$) and downstream of the Merced River inflow ($10 \mu\text{g/L}$). During WY 92, only one site, Lander Avenue - the single site upstream of the drainage inflows, exceeded the water quality objectives for molybdenum. The noncompliance is a result of natural conditions. During WY 92, flows at the Lander Avenue site were very low and most flow resulted from ground water seepage.

Selenium and boron water quality objectives are delineated by location on the river, season, and water year type. Throughout WY 92, three sites exceeded their respective approved boron objectives. Two of the sites, the San Joaquin River at Fremont Ford and the San Joaquin River at Hills Ferry, are upstream of the Merced River inflow (objective, 2.0 mg/L). Compliance with this objective begins in 1993. The other site, the San Joaquin River at Crows Landing is downstream of the Merced River inflow (objective 1.3 mg/L). Compliance with this objective was to begin October 1991.

During WY 92, selenium concentrations in the San Joaquin River at both Hills Ferry and Fremont Ford exceeded the 1993 objective several times. In the downstream reach of the river, the Crows Landing site exceeded the adopted objective once. Selenium concentrations diminished farther downstream. Lack of freshwater dilution contributes to the higher concentrations found in the critically dry water years.

A sampling frequency study was performed at the Crows Landing site. The results indicate that weekly sampling sufficiently characterizes the monthly mean concentrations of boron and selenium during a critically dry year.

Water quality in the San Joaquin River will continue to be evaluated against objectives and milestones in upcoming water years.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. Water quality samples were collected at eight monitoring sites along a 60-mile section of the River extending from near Stevinson in Merced County to Airport Way near Vernalis in San Joaquin County (Figure 1). The purpose of this monitoring program was to compile an on-going database for selected inorganic constituents found in San Joaquin River water. This database is used to assess the effects of agricultural drainage water on the quality of the San Joaquin River. A long-term database is essential to assess the effects of the implementation of regional agricultural drainage reduction programs on overall river water quality. This report contains the results of this monitoring program for data collected from October 1991 through September 1992. This period comprises Water Year 1992 (WY 92). Reports have been issued for data collected from May 1985 through September 1991 (WYs 86-91) (James, *et al.*, 1988; Westcot, *et al.*, 1989a, 1990, 1991, and 1992). This monitoring program was designed to complement monitoring programs conducted by other state, federal, and local agencies.

STUDY AREA

The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue (Highway 165) near Stevinson to Airport Way near Vernalis. Monitoring sites are located near each of the eight river overcrossings on this section of the River (Figure 2).

There are five major tributaries to the San Joaquin River within this study area: Salt Slough, Mud Slough (north), and the Merced, Tuolumne, and Stanislaus Rivers. Salt Slough and Mud Slough (north) drain the Grassland Area of western Merced County and discharge to the San Joaquin River in the southern portion of the study area (Figure 2). These two sloughs are the major source of agricultural subsurface drainage water discharges to the San Joaquin River. They carry a varying mixture of surface and subsurface agricultural drainage, operational spillage from irrigation canals, and seasonal drainage from duck ponds flooded each winter for waterfowl habitat. The Merced, Tuolumne, and Stanislaus Rivers are east side streams which drain the Sierra Nevada and contain relatively high quality water.

In addition to the five major tributaries, there are also a number of smaller tributaries, as well as surface and subsurface agricultural drains, that discharge to the San Joaquin River within the study area. The significant inflows and their locations, referenced by river mile are listed in Table 1. The monitoring sites are also listed in this table. A full description of the inflow points that occur in this 60-mile section of the river is in James, *et al.*, (1989).

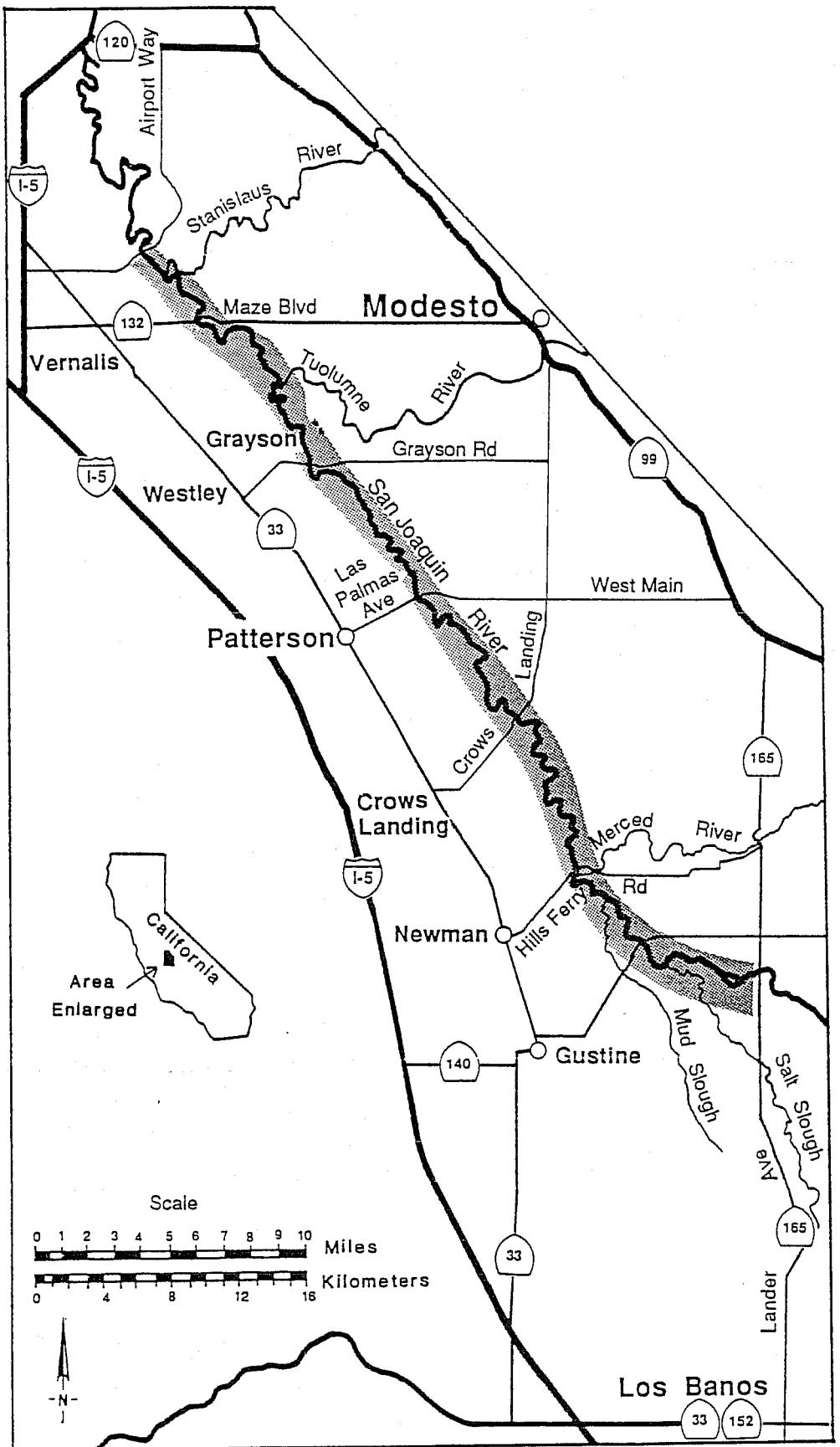


Fig. 1 Location Map

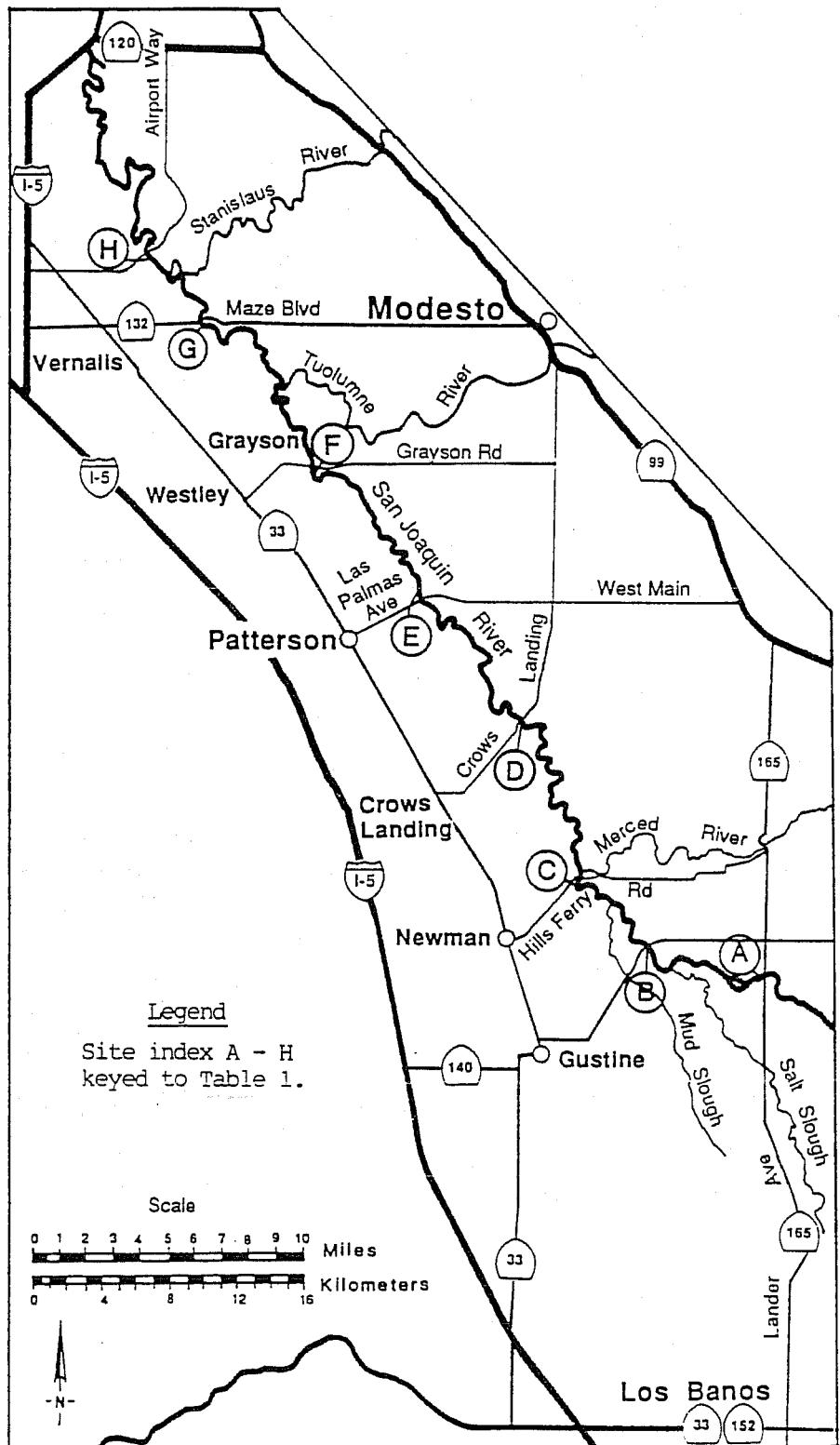


Fig. 2. Index Map

Table 1. Tributaries and Drains to the San Joaquin River Between Monitoring Stations: Lander Avenue and Airport Way

River Mile	Description	Water make up
132.9	Lander Avenue (Site A)	
129.7	Salt Slough	T,S
125.1	Fremont Ford (Site B)	
121.2	Mud Slough	T,S
119.6	Newman Wasteway	O,S
119.5	Newman Drainage District Collector Line A	T
119.1	Hills Ferry Road Drain	S
118.8	Hills Ferry Road (Site C)	
118.2	Merced River	N
117.5	Newman Drainage District Lateral 1	T
117.2	Azevedo Road Drain	S
113.4	Freitas Rd. Drain and South of Freitas Rd. Drain.	S
112.0	Turlock Irrigation District Lateral 6	S,O
109.0	Orestimba Creek	N,S
107.2	Crows Landing Road (Site D)	
105.0	Spanish Grant, Marshall Rd., Moran Rd. Drain	S,T
103.5	Turlock Irrigation District Lateral 5	S
100.0	Ramona Lake Main Drain	S,T
98.6	Patterson Water District Main Drain	S,T
98.4	Las Palmas Launching Facility (Site E)	
97.6	Olive Avenue Drain	S
97.3	Lemon Avenue Drain	S
97.0	Eucalyptus Avenue Drain	S
95.2	Turlock Irrigation District Lateral 3	S
92.9	Del Puerto Creek	N,S
91.4	Houk Ranch Drain	S,T
90.3	Turlock Irrigation District Lateral 4	S
89.1	Grayson Road (Site F)	
87.0	Old San Joaquin River Channel	S
83.7	Tuolumne River	N
81.1	Merced Irrigation District Lateral 4	S
79.9	Hospital/ Ingram Creeks	S,T
78.9	Center Road Drain	S
77.6	Blewett Drain	S,T
77.4	Blewett Drain	S
77.3	Maze Boulevard (Site G)	
74.9	Stanislaus River	N
73.6	Airport Way (Site H)	

LEGEND

-
- S Surface Agricultural Drain
 - T Subsurface Agricultural Drain
 - N Natural Stream
 - O Operation Spillage

TEMPORAL VARIATIONS IN STREAMFLOW

A water year (WY) extends from 1 October of one year to 30 September of the following year. The Sacramento River Index (see the San Joaquin River Basin Plan, SWRCB, 1989) is used to classify water year type in the Sacramento and San Joaquin River Basins. WY 85 was classified as a dry water year and WYs 87-91 were classified as critical water years. WY 86 was a wet year. WY 92, presented in this report, was the sixth consecutive critically dry year.

METHODS

The Regional Board monitoring program for the San Joaquin River began in May of 1985 and continued through the 1992 WY. The grab samples for Water Year 1992 were collected on a weekly basis for all eight sites. Water temperature, pH, electrical conductivity (EC), and sample time were recorded in the field at each site. Laboratory analyses for total recoverable selenium, boron, and EC² were performed on all samples. On a monthly basis, samples from all sites were analyzed for chloride, sulfate and hardness, while samples from selected sites were analyzed for total molybdenum, copper, chromium, lead, nickel and zinc. The Hills Ferry road site is also analyzed monthly for carbonate, bicarbonate, total alkalinity, calcium, potassium, sodium, total dissolved solids, and selected dissolved trace elements.

Samples were collected in polyethylene bottles. The selenium and trace element sample bottles were washed and acid rinsed in the laboratory before use. All samples bottles were rinsed three time with the water to be sampled prior to sample collection.

Selenium and trace elements samples were preserved with ultra-pure nitric acid to lower the pH of the sample to two or less . Mineral samples were kept on ice until submitted to the laboratory for analysis. A quality control and quality assurance program was conducted with blind replicate and spiked samples. Duplicate samples were randomly collected at 10 percent of the sites and 50 percent of the duplicates were spiked for the laboratory quality assurance program. The reported results fall within the quality assurance tolerance guidelines shown in Table 2.

RESULTS

The following results are presented by site in the order of the site's location on the San Joaquin River (SJR). The first site is the furthest upstream and the subsequent sites discussed are downstream from this site. The San Joaquin River Basin Plan water quality objective (WQO) concentrations for the SJR are shown in Table 3. A summary of monthly mean selenium and boron results is presented in Tables 4 and 5. Data below detection levels were assumed to be at the detection level for the purpose of calculating monthly means. Tables 6 and 7 summarize annual median, maximum and minimum values for WY 85-92. All the data gathered for each site is in the appendix of this report.

² Electrical conductivity values reported in the Appendix are laboratory EC values.

TABLE 2
Quality Assurance Tolerance Guidelines

Constituent	Recovery Range at Low Levels ($\mu\text{g/L}$)*	Acceptable Blind Duplicate Spike Recovery Range
Copper	1-20 +/- 5	> 20 70-130%
Chromium	1-20 +/- 5	> 20 70-130%
Lead	5-25 +/- 8	> 25 60-140%
Molybdenum	1	90-110%
Nickel	5-25 +/- 6	>25 65-135%
Selenium	0.2	90-110%
Zinc	1-20 +/- 6	> 20 70-130%
Boron	50	85-115%
Chloride	5000	85-115%

* For certain constituents, recovery is expressed as an absolute value rather than a percentage at low levels. For example, if the result of copper analysis for a particular sample is 10 $\mu\text{g/L}$, a duplicate analysis must fall between 5 $\mu\text{g/L}$ and 15 $\mu\text{g/L}$. If the sample is greater than 20 $\mu\text{g/L}$, recovery is expressed as a percent and must be between 70% and 130%. If a recovery range is not shown at low levels, the detection limit is given.

The site furthest upstream on the San Joaquin River was at Lander Avenue. The water quality at this site was fairly good with respect to selenium (median concentration 0.30 $\mu\text{g/L}$) and boron (median concentration 0.46 mg/L). In contrast to the relatively low values of boron and selenium, this site had the highest median concentrations of molybdenum and chloride, of 34 $\mu\text{g/L}$ and 460 mg/L respectively. This site exceeded the monthly mean molybdenum objective (19 $\mu\text{g/L}$) in the months listed below. The maximum WQO for this site was never exceeded. All other San Joaquin River sites downstream of Lander Avenue consistently met the applicable molybdenum objective.

<u>Month</u>	<u>Molybdenum ($\mu\text{g/L}$)</u>
Oct.	50
Dec.	38
Jun.*	36
July*	46
Aug.*	42
Sept.*	45

* Only one sample was analyzed for molybdenum during these months.

TABLE 3

Water Quality Objectives as Adopted by the Central Valley Regional Board for the San Joaquin Basin (5C)

<u>Constituent</u>	<u>Water Quality Objectives</u>		<u>Compliance Date</u>
San Joaquin River, mouth of the Merced River to Vernalis (Delta Inflow)			
Selenium	5 µg/l monthly mean	12 µg/l max.	Oct. 1, 1991
	8 µg/l monthly mean (critical year only)		Oct. 1, 1991
Molybdenum	10 µg/l monthly mean	15 µg/l max.	Jan. 1, 1990
Boron	0.8 mg/l monthly mean (15 March-15 Sept)	2.0 mg/l max.	Oct. 1, 1991
	1.0 mg/l monthly mean (16 Sept-14 March)	2.6 mg/l max.	Oct. 1, 1991
	1.3 mg/l monthly mean (critical year only)		Oct. 1, 1991
Salt Slough, Mud Slough (north), San Joaquin River, Sack Dam to mouth of the Merced River			
Selenium	10 µg/l monthly mean	26 µg/l max.	Oct. 1, 1993
Molybdenum	19 µg/l monthly mean	50 µg/l max.	Jan. 1, 1990
Boron	2.0 mg/l monthly mean (15 March-15 Sept)	5.8 mg/l max.	Oct. 1, 1993

TABLE 4. Summary of WY 92 Monthly Mean Selenium Values ($\mu\text{g/L}$)

	Lander Ave.	Fremont Ford Rd.	Hills Ferry Rd.	Crows Landing Rd.	Las Palmas Ave.	Grayson Rd.	Maze Blvd.	Airport Way
Oct-91	0.22	2.9	1.6	1.0	1.0	1.4	1.1	1.1
Nov-91	0.33	7.6	5.5	2.2	2.1	2.2	1.4	1.1
Dec-91	0.30	6.4	4.8	1.5	1.3	1.5	1.2	1.0
Jan-92	0.42	16	10	4.0	3.7	3.6	2.5	2.1
Feb-92	0.43	12	8.0	4.2	3.9	3.8	2.7	2.3
Mar-92	0.32	14	11	5.9	5.5	5.4	4.3	3.6
Apr-92	0.32	17	14	8.2	6.5	6.2	3.8	2.2
May-92	0.30	10	10	5.5	4.4	4.6	2.0	1.8
Jun-92	0.53	15	16	6.4	5.1	4.0	2.4	2.0
Jul-92	0.26	2.3	8.7	4.7	3.7	3.1	2.0	1.3
Aug-92	0.23	0.95	4.7	3.5	2.3	2.3	1.7	1.2
Sep-92	0.20	1.9	4.3	1.3	1.1	1.2	0.90	0.73

TABLE 5. Summary of WY 92 Monthly Mean Boron Values (mg/L)

	Lander Ave.	Fremont Ford Rd.	Hills Ferry Rd.	Crows Landing Rd.	Las Palmas Ave.	Grayson Rd.	Maze Blvd.	Airport Way
Oct-91	0.75	1.1	1.0	0.54	0.51	0.51	0.46	0.39
Nov-91	0.17	1.2	1.1	0.46	0.49	0.51	0.36	0.30
Dec-91	0.48	1.9	1.9	0.61	0.62	0.62	0.50	0.44
Jan-92	0.27	3.0	2.3	0.97	0.96	0.94	0.66	0.60
Feb-92	0.13	2.1	1.8	0.95	0.83	0.83	0.58	0.52
Mar-92	0.25	2.3	2.3	1.3	1.3	1.2	0.95	0.79
Apr-92	0.33	2.5	2.4	1.5	1.3	1.1	0.79	0.49
May-92	0.40	2.9	2.0	1.0	0.89	0.85	0.46	0.33
Jun-92	0.64	2.5	2.7	1.4	1.1	0.87	0.70	0.47
Jul-92	0.76	0.78	1.8	1.0	0.91	0.72	0.66	0.43
Aug-92	0.89	0.58	1.2	0.8	0.73	0.64	0.58	0.40
Sep-92	0.94	0.84	1.4	0.67	0.67	0.57	0.47	0.36

Large numbers in bold italics indicate exceedance of applicable current or future monthly mean objectives.

Table 6. Ranges of Selenium and Molybdenum Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88, WY 89, WY 90, and WY 91 taken from Westcot, et al., 1989, 1990, 1991, and 1992.)

WY 1985 DRY		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	1 1 2 (6)	1 2 3 (6)	1 2 3 (6)	<1 3 4 (6)	1 3 4 (6)	1 4 8 (6)	<1 3.5 7 (6)
WY 1986 WET		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	0.6 (<1) 1 4 (19)	0.8 (<1) 1.5 2.4 (19)	0.9 (<1) 2.2 4 (16)	<1 2 5 (18)	<1 2 4 (19)	<1 4 8 (19)	<1 0.2 (<1) 0.3 5 (19)
Mo	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	0.6 (<1) 1.6 (<5) 16 (16)	<1 <5 8 (15)	<1 <5 13 (12)	<1 <5 12 (17)	<1 <5 14 (14)	2.6 (<5) 5.1 14 (16)	2.9 (<5) 5 17 (16)
WY 1987 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	0.9 2.3 3.2 (15)	1.4 3.3 5.8 (11)	3.4 4.6 9.3 (11)	3.4 4.8 10 (11)	3.6 5.6 12 (15)	6.6 11 21 (15)	4.3 10 26 (14)
Mo	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	1 (<5) 2 (<5) 2 (<5) (11)			4 (<5) 4 5 (10)	<5 7 12 (11)	4 (<5) 7 12 (11)	4 (<5) 7 14 (10)
WY 1988 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	0.8 2.7 6.5 (41)	1.9 5.1 6.5 (13)	2.4 5.8 8.5 (12)	2.0 6.2 9.1 (14)	0.8 7.4 12 (42)	1.0 10 20 (41)	1.3 12 23 (40)
Mo	($\mu\text{g/L}$)	Minimum Median Maximum # Samples	2 3 4 (6)			3 5 7 (35)	4 6 11 (30)	3 15 22 (35)	3 15 22 (35)

Table 6 (continued). Ranges of Selenium and Molybdenum Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88, WY 89 and WY 90, and WY 91 taken from Westcot, et al., 1989, 1990, 1991, and 1992.)

WY 1989 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 2.9 Median 2.9 Maximum 6.8 # Samples (46)	1.4 3.2 4.4 (14)	3.5 5.8 8.0 (13)	3.0 6.0 14 (13)	3.4 6.9 17 (47)	2.8 9.8 23 (46)	3.4 12 32 (47)	0.3 0.5 1.3 (46)
Mo (µg/L)	Minimum 1 Median 2 Maximum 5 # Samples (44)				2 4 7 (46)	3 6 11 (46)	1 16 30 (47)	1 16 30 (47)
WY 1990 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 0.8 Median 2.4 Maximum 9.6 # Samples (49)	1.7 4.0 9.8 (35)	2.9 5.0 10 (12)	1.7 4.6 10 (12)	1.6 7.2 13 (49)	2.7 11 26 (49)	4.4 14 33 (49)	<0.2 0.4 1.7 (49)
Mo (µg/L)	Minimum 1 Median 2 Maximum 5 # Samples (46)	1 4 6 (20)			2 5 8 (48)	3 8 18 (48)	4 8 14 (26)	3 20 59 (48)
WY 1991 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 0.5 Median 1.9 Maximum 4.8 # Samples (54)	0.8 2.7 5.6 (54)	1.0 4.3 7.3 (38)	0.6 4.9 8.3 (38)	0.7 6.1 11 (53)	1.0 9.5 24 (53)	0.9 13 30 (52)	0.2 0.4 0.8 (52)
Mo (µg/L)	Minimum 1 Median 2 Maximum 4 # Samples (45)				0.6 6 9 (42)	1 12 19 (44)	1 12 35 (36)	0.3 22 74 (43)
WY 1992 CRITICAL	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
Se (µg/L)	Minimum 0.4 Median 1.5 Maximum 4.4 # Samples (57)	0.4 2.1 5.4 (57)	0.6 3.3 7.2 (53)	0.5 3.2 8.2 (54)	0.5 4.6 11 (57)	1.0 8.6 19 (58)	0.8 11 25 (58)	0.1 0.3 0.6 (48)
Mo (µg/L)	Minimum 1 Median 2 Maximum 5 # Samples (09)				3 5 10 (17)	5 10 15 (10)	7 11 15 (09)	6 34 50 (17)

Table 7. Ranges of Electrical Conductivity and Boron Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88, WY 89, WY 90, and WY 91 taken from Westcot et al., 1989, 1990, 1991, and 1992).

WY 1985 DRY		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC	(μ mhos/cm)	Minimum 480	620	690	640	630	730	640	192
	Median 540	860	1000	1050	995	1325	1150	700	
	Maximum 680	900	1050	1200	1200	2200	1900	1300	
	# Samples (6)	(6)	(5)	(6)	(6)	(6)	(6)	(6)	(5)
B	(mg/L)	Minimum 0.20	0.25	0.38	0.26	0.27	0.45	0.33	<0.01
	Median 0.27	0.43	0.48	0.62	0.64	1.10	0.93	0.10	
	Maximum 0.45	0.60	0.78	0.86	0.85	1.60	1.20	0.36	
	# Samples (6)	(6)	(5)	(6)	(6)	(6)	(6)	(6)	(5)
WY 1986 WET		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC	(μ mhos/cm)	Minimum 180	200	280	240	270	410	94	73
	Median 540	700	960	870	815	1100	905	400	
	Maximum 980	1100	1700	1800	1700	2600	2300	930	
	# Samples (18)	(17)	(15)	(18)	(18)	(18)	(18)	(18)	(18)
B	(mg/L)	Minimum 0.10	0.13	0.17	0.11	0.14	0.29	0.09	<0.01
	Median 0.22	0.39	0.57	0.56	0.59	0.91	0.65	0.10	
	Maximum 0.7	0.70	1.2	1.7	1.2	2.2	1.8	0.61	
	# Samples (17)	(17)	(15)	(18)	(18)	(18)	(18)	(18)	(18)
WY 1987 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC	(μ mhos/cm)	Minimum 340	490	1200	1200	1200	1600	1330	650
	Median 804	1100	1300	1360	1320	1720	1730	1200	
	Maximum 930	1420	1890	1960	1990	2600	2880	1650	
	# Samples (13)	(9)	(9)	(9)	(13)	(10)	(12)	(12)	(13)
B	(mg/L)	Minimum 0.18	0.30	0.59	0.70	0.67	0.53	0.81	0.10
	Median 0.43	0.64	0.88	0.95	0.94	1.6	1.6	0.21	
	Maximum 0.62	1.1	1.6	1.8	1.9	3	3	0.35	
	# Samples (15)	(11)	(11)	(11)	(15)	(13)	(14)	(14)	(15)
WY 1988 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC	(μ mhos/cm)	Minimum 650	1010	1300	750	1180	1380	1260	320
	Median 900	1400	1580	1600	1600	1990	1950	1550	
	Maximum 1450	1600	1950	2150	2150	3100	2950	2100	
	# Samples (43)	(13)	(12)	(14)	(43)	(41)	(42)	(40)	
B	(mg/L)	Minimum 0.28	0.50	0.66	0.48	0.46	0.57	0.41	0.03
	Median 0.50	0.90	1.0	1.2	1.2	1.7	1.8	0.30	
	Maximum 0.95	1.1	1.5	3	2	3.1	2.8	0.47	
	# Samples (43)	(13)	(12)	(14)	(43)	(41)	(42)	(40)	

Table 7 (continued). Ranges of Electrical Conductivity and Boron Concentration by Water Year (WY) Type for Monitoring Sites Along the Lower San Joaquin River (Data for WY 85, WY 86, and WY 87 taken from James, et al., 1988. Data for WY 88, WY 89, WY 90, and WY 91 taken from Westcot et al., 1989, 1990, 1991, and 1992).

WY 1989 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ($\mu\text{mhos/cm}$)	Minimum	720	880	1160	1220	1000	1360	1300	380
	Median	980	1290	1480	1490	1520	1930	2010	1500
	Maximum	1510	1740	2100	2220	2210	3350	3300	1990
	# Samples	(46)	(14)	(13)	(13)	(47)	(46)	(47)	(47)
B (mg/L)	Minimum	0.37	0.60	0.64	0.76	0.68	0.69	0.67	0.06
	Median	0.54	0.80	0.9	1.0	1.2	1.7	1.8	0.32
	Maximum	1.0	1.2	1.6	1.8	1.9	3.0	3.3	0.54
	# Samples	(45)	(14)	(13)	(13)	(46)	(46)	(46)	(46)
WY 1990 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ($\mu\text{mhos/cm}$)	Minimum	600	930	1250	1060	1180	1120	1180	440
	Median	920	1340	1430	1530	1710	2490	2400	1500
	Maximum	1380	1640	1900	2160	2030	4120	3070	2940
	# Samples	(49)	(35)	(12)	(12)	(49)	(46)	(49)	(48)
B (mg/L)	Minimum	0.31	0.55	0.66	0.67	0.67	0.88	0.82	0.09
	Median	0.50	0.79	0.91	1.1	1.2	2.1	2.0	0.33
	Maximum	1.1	1.2	1.2	1.5	1.7	3.2	3.3	0.69
	# Samples	(49)	(35)	(12)	(12)	(49)	(48)	(49)	(49)
WY 1991 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ($\mu\text{mhos/cm}$)	Minimum	410	530	600	560	560	750	600	150
	Median	990	1280	1670	1735	1720	2620	2620	2235
	Maximum	1680	1750	2310	2450	2490	4360	4290	3420
	# Samples	(54)	(54)	(38)	(38)	(53)	(53)	(52)	(52)
B (mg/L)	Minimum	0.20	0.28	0.31	0.28	0.30	0.46	0.37	0.08
	Median	0.46	0.64	0.92	1.0	1.1	1.9	2.0	0.43
	Maximum	1.2	1.3	1.7	1.9	2.1	3.4	4.4	0.75
	# Samples	(54)	(54)	(38)	(38)	(53)	(53)	(52)	(52)
WY 1992 CRITICAL		AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
EC ($\mu\text{mhos/cm}$)	Minimum	389	410	895	880	670	880	820	100
	Median	925	1260	1530	1570	1570	2630	2670	2200
	Maximum	1450	1540	1950	2060	2180	3620	3800	3990
	# Samples	(58)	(58)	(53)	(54)	(58)	(58)	(58)	(53)
B (mg/L)	Minimum	0.16	0.20	0.25	0.24	0.23	0.34	0.28	0.038
	Median	0.44	0.61	0.74	0.86	1.0	1.9	1.9	0.46
	Maximum	0.93	1.1	1.4	1.5	1.8	3.2	4.9	0.98
	# Samples	(58)	(58)	(53)	(53)	(57)	(56)	(57)	(52)

The next site sampled downstream on the SJR was at Fremont Ford, which is downstream of the confluence of Salt Slough. The Fremont Ford site had the highest median concentrations for this study with EC, selenium, and hardness values of 2670 $\mu\text{mhos}/\text{cm}$, 11 $\mu\text{g}/\text{L}$ and 553 mg/L , respectively. This site exceeded the WY 94 monthly mean WQO for boron (2.0 mg/L) and selenium (10 $\mu\text{g}/\text{L}$) several times (shown below).

<u>Months</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g}/\text{L}$)</u>
Jan.	3.0	16
Feb.	2.1	12
Mar.	2.3	14
Apr.	2.5	17
May	2.9	11
Jun.	2.5	15

However, this site did not exceed the WY 94 maximum WQO concentrations for either boron (5.8 mg/L) or selenium (26 $\mu\text{g}/\text{L}$) in the 1992 WY. The highest concentrations of boron and selenium found at this site were 4.9 mg/L and 25 $\mu\text{g}/\text{L}$ respectively.

The next downstream sampling site on the SJR was near Hills Ferry Road³, just downstream of the confluence of Mud Slough (north). The median concentrations of Se (8.6 $\mu\text{g}/\text{L}$), EC (2630 $\mu\text{mhos}/\text{cm}$), Mo(10 $\mu\text{g}/\text{L}$), and B (1.9 mg/L), were close to the same levels as at the Fremont Ford site. This site had the highest median concentration of sulfate on the SJR at 500 mg/l . The site exceeded the future WY 94 monthly mean water quality objectives for both selenium and boron for several months during WY 92 (shown below).

<u>Month</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g}/\text{L}$)</u>
Jan.	2.3	---
Mar.	2.3	11
Apr.	2.4	14
May	---	10
Jun.	2.7	16

The WY 94 maximum WQO concentrations of selenium and boron were never exceeded at this location for the water year of 1992. The maximum concentration found for selenium and boron at this site were 19 $\mu\text{g}/\text{L}$ and 3.2 mg/L respectively.

The SJR near Crows Landing Road is located downstream of the Merced River and has different water quality objectives (Table 3).

³ The boron values for August 7, 1992 for both Hills Ferry (5.0 ppm) and Crows Landing (2.2 ppm) were the highest levels found by the Regional Board since sample collection began in 1985. Since these values differ significantly from other boron data collected in the July-September 1992 time period (i.e. there was no trend of elevated boron values), the data was rejected.

Since the 1992 water year was classified as a critical water year, the critical year WQO apply. The monthly mean WQO for selenium (8.0 µg/L) was slightly exceeded in the month of April (8.2 µg/L) and the boron standard (1.3 mg/L) was exceeded in April and June (1.5 and 1.4 mg/L respectively). The maximum WQO concentrations for boron, molybdenum and selenium were not exceeded in the 1992 WY.

The sampling sites downstream of Crows Landing Road had decreasing concentrations of boron and selenium. The lowest median values of boron (0.44 mg/L) and EC (925 µmhos/cm) were found at the downstream end of the study area - the SJR at Airport Way.

CROWS LANDING SAMPLING FREQUENCY STUDY

A comparison between daily and weekly sampling frequency was made at Crows Landing Road for the months of February through June for samples collected during the 1992 WY (Table 8). The highest variation in flow and constituent concentration would be expected in this time period due to the combination of rainfall events, reservoir releases, and agricultural and wetland discharges.

Monthly mean values based on daily data and monthly mean values based on weekly data were determined for boron and selenium. A comparison between the means was made with a student t test. At a 95% confidence level, there was no significant difference between monthly means calculated based on daily sampling as compared to monthly means calculated based on weekly sampling.

This study demonstrates that, during a critical water year, weekly sampling adequately characterizes the monthly mean concentration of boron and selenium. During wetter water years, the variation in river flow would likely be greater, which may require a higher sampling frequency to adequately characterize the monthly mean concentration.

DISCUSSION

Boron and Selenium

In the WY 92 Agricultural Drainage Report for the Grassland Area (Karkoski and Tucker, 1993), it was shown that significant reductions in selenium (65%) and boron (55%) loads in Mud and Salt Sloughs have occurred since WY 1989. These load reductions have lead to less severe and less frequent exceedance⁴ of water quality standards in the San Joaquin River.

Table 9 shows that as the drought continued, load reductions were significant enough to greatly reduce the frequency of exceedance of selenium and boron standards. Figures 3 and 4 show the trends in annual median boron and selenium concentrations for Hills Ferry and

⁴ The compliance date for boron and selenium water quality standards at Crows Landing did not become effective until October, 1991 and the standards for Hills Ferry have an October, 1993 compliance date. Determination of "exceedances" for years prior to the effective compliance date is done only to illustrate the effect of load reductions on water quality and does not imply an actual violation of a standard.

TABLE 8

Comparison of Weekly and Daily WY 1992 Crows Landing Data

BORON						
MONTHS	DAILY VARIANCE	WEEKLY VARIANCE	DAILY MEANS	WEEKLY MEANS	# OF DATA POINTS DAILY	# OF DATA POINTS WEEKLY
February	0.095	0.056	0.95	0.91	27	4
March	0.039	0.036	1.3	1.3	28	4
April	0.024	0.009	1.5	1.5	28	4
May	0.041	0.055	1.0	0.95	27	4
June	0.051	0.083	1.4	1.4	26	4

SELENIUM						
MONTHS	DAILY VARIANCE	WEEKLY VARIANCE	DAILY MEANS	WEEKLY MEANS	# OF DATA POINTS DAILY	# OF DATA POINTS WEEKLY
February	2.3	2.0	4.2	4.2	27	4
March	0.51	0.24	5.9	6.1	28	4
April	1.7	2.8	8.2	8.1	28	4
May	6.7	5.8	5.5	5.4	27	3
June	3.4	3.4	6.4	7.1	27	4

The above statistics provide the daily and weekly variances and means for samples collected within a given month.

Crows Landing. A comparison of the two figures indicates that load reductions have been more successful in reducing selenium concentration than boron concentration.

The difference in the success in reducing selenium concentrations versus boron concentrations can be explained by reviewing the spatial distribution of high boron and high selenium areas. Groundwater high in boron is ubiquitous to the Grasslands Area and high selenium areas are limited to agricultural areas south west of the Grassland Water District (SJVDP, 1990). In addition to agricultural sources of boron and selenium from tile drainage, shallow groundwater high in boron (and low in selenium) surrounds Mud and Salt Sloughs and the San Joaquin River near the Grasslands. As expected, drainage load reductions have a more significant impact on the downstream concentration of the constituent (i.e. selenium) that is not naturally present at elevated background levels. Other strategies, in addition to drainage load reductions, may need to be developed to meet boron water quality objectives.

TABLE 9

Number of Exceedances of Selenium and Boron Standards

Water Year	Crows Lndg (Se)	Hills Ferry (Se)	Crows Lndg (B)	Hills Ferry (B)
1987	2*	7*	3*	0**
1988	3	7	4	2
1989	3	7	4	0
1990	4	6	7	5
1991	3	6	4	2
1992	1	4	2	3

Boron standard at Hills Ferry applies from March 15- September 14.

* No sample was collected in March. ** No Samples were collected in March-May.

Figures 5 and 6 demonstrate the impact of load reductions from WY 1991 to WY 1992, which were hydrologically similar. From WY 91 to WY 92 loads of boron and selenium were reduced by 21% and 30%, respectively, from Mud and Salt Sloughs. This load reduction lead to reductions in boron and selenium concentrations in most months.

Figures 7 and 8 show the dilution effect of the tributaries from the east side of the valley on the San Joaquin River. The Merced River enters the San Joaquin downstream of Hills Ferry. The Tuolumne and Stanislaus Rivers enter the San Joaquin downstream of Crows Landing. Boron and selenium standards are consistently met downstream of the confluence of the San Joaquin River and Tuolumne River.

Figure 3

Median Boron Values for WYs 1987-1992

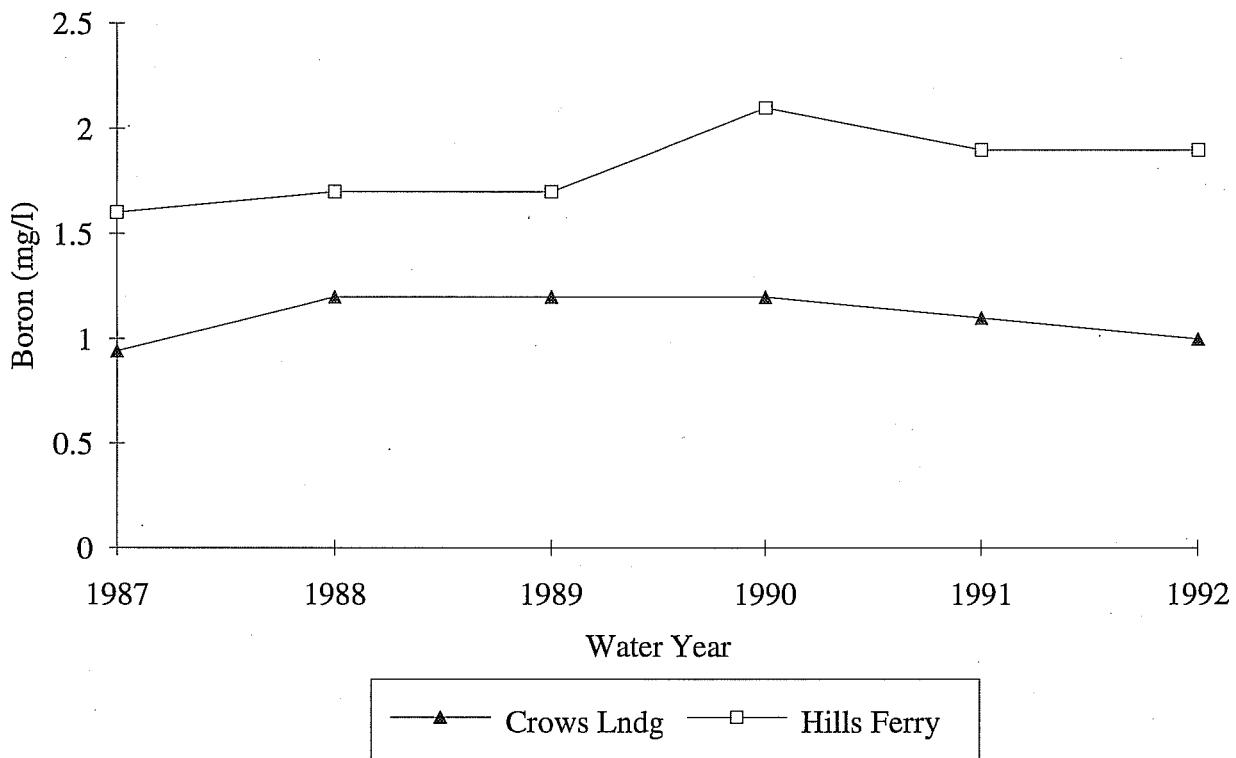


Figure 4

Median Selenium Values for WYs 1987-1992

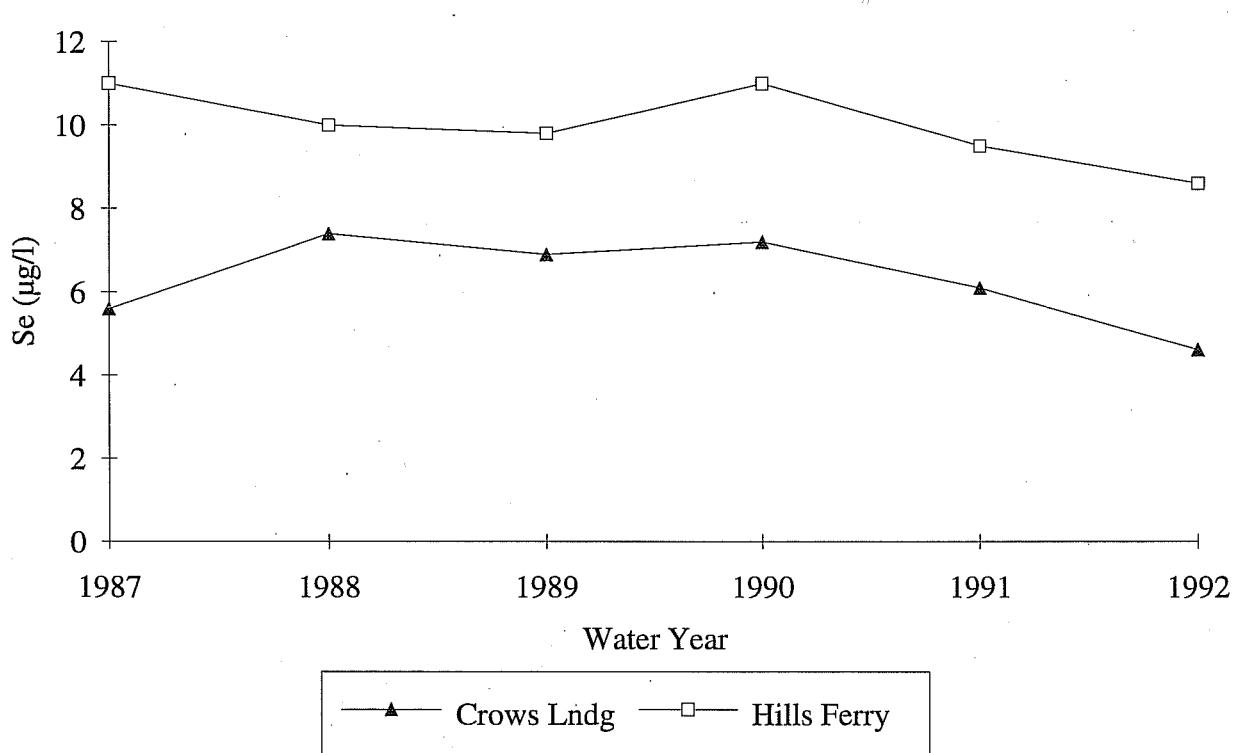


Figure 5

Monthly Mean Boron Concentration in the San Joaquin River at Crows Landing

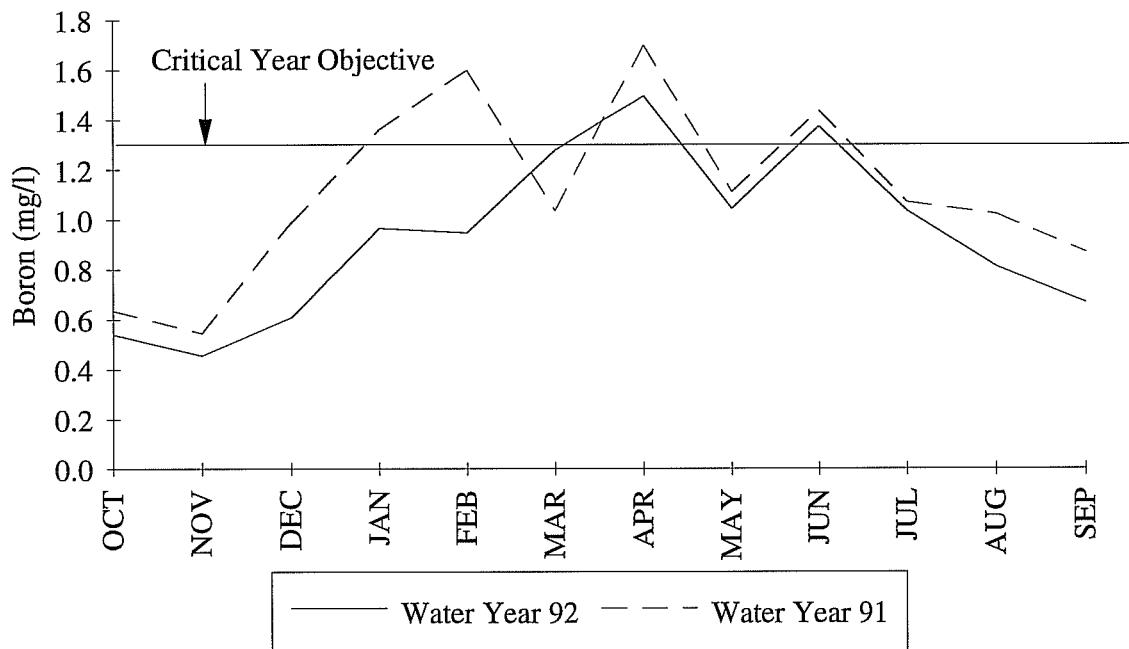


Figure 6

Monthly Mean Concentration of Selenium in the San Joaquin River at Crows Landing

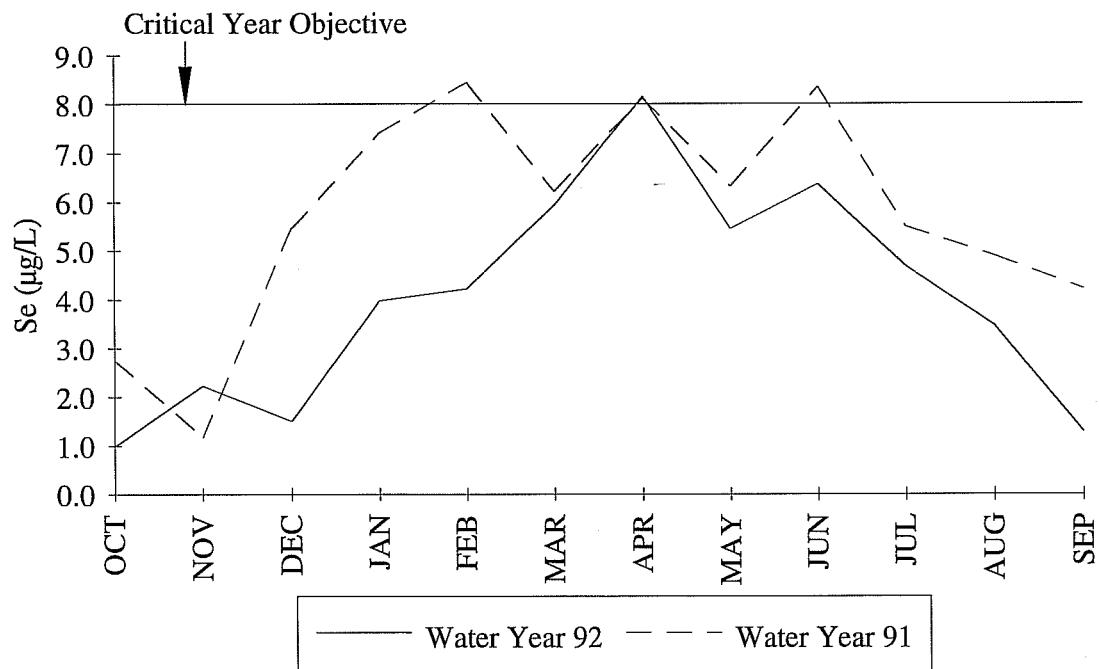


Figure 7

Monthly Mean Selenium Concentration at Three Sites on the San Joaquin River

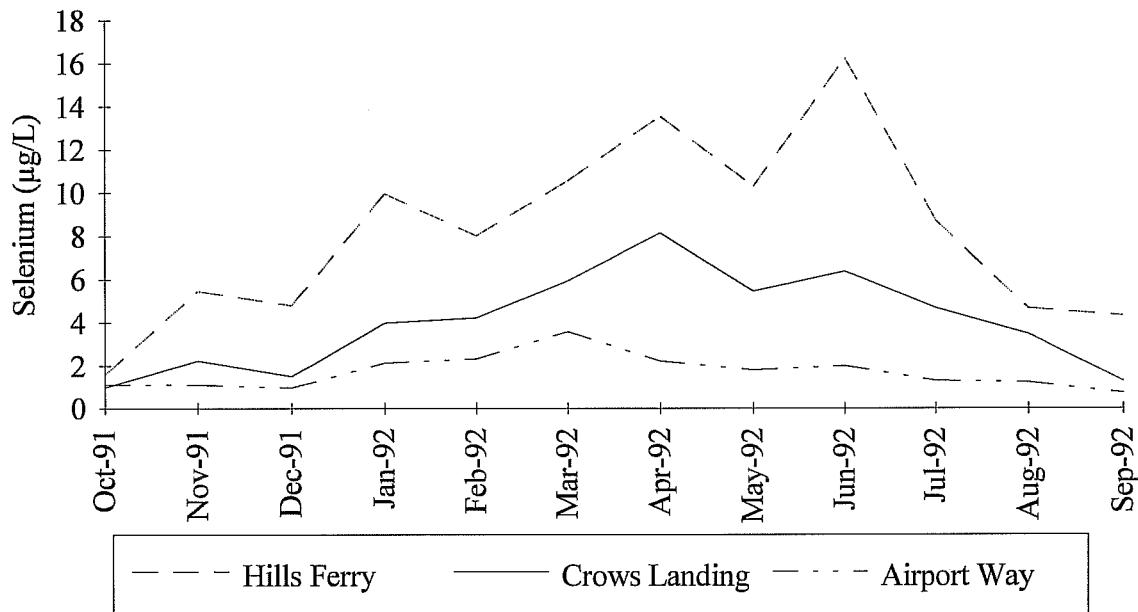
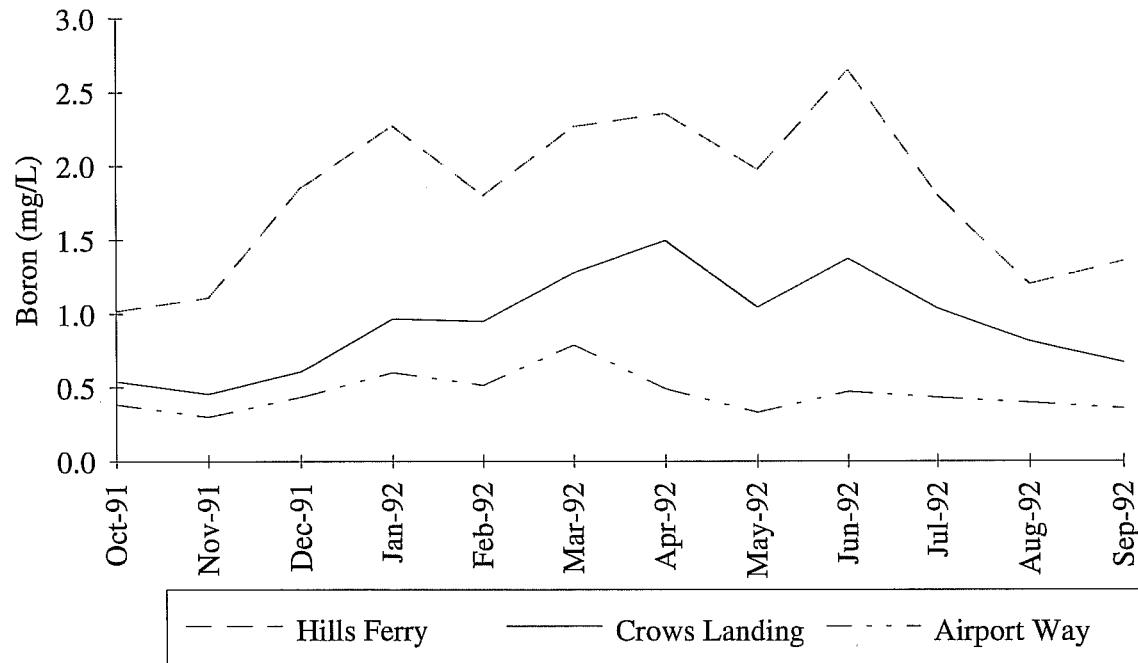


Figure 8

Monthly Mean Boron Concentration at Three Sites on the San Joaquin River



Other Elements of Concern

Molybdenum data collected from the San Joaquin River at Lander Avenue site indicated frequent violations of the applicable water quality standard. Flow during the drought years has generally been less than 1,000 acre-feet per month (15 cubic feet per second) and as low as 8 acre-feet per month at the Lander Avenue site. The low flow reflects the diversion of the head waters into the Friant-Kern Canal and a lack of agricultural return flows upstream of this site. Molybdenum levels in the groundwater near the sampling site are in the range of 100-1000 µg/L (SJVDP, 1990). Since flows are low and ground water molybdenum levels are high, the high levels of molybdenum found at the Lander Avenue site are likely due to ground water accretions.

Total recoverable chromium, copper, lead, nickel, and zinc were analyzed at the Hills Ferry and Crows Landing sites. Copper, lead, nickel, and zinc water quality criteria vary with hardness (Marshack, 1993). Toxicity is not expected to occur from these four elements due to the combination of high hardness (210 mg/L to 720 mg/L) and low levels of the four elements at these two sites.

Total recoverable chromium is analyzed to determine whether potential problems related to hexavalent chromium exist. Total chromium values at the Hills Ferry site were below the toxicity value (11 µg/L) of hexavalent chromium. Two sampling events at the Crows Landing site found total chromium values above 11 µg/L (12 µg/L and 15 µg/L).

Table 10 shows the results of analyses of dissolved trace elements for the Hills Ferry site. In almost all cases, the filtered samples show no detectable levels of the element of concern. The exceptions are three samples which showed copper concentrations slightly above the detection limit and one sample which contained zinc slightly above the detection limit. A comparison between total recoverable and dissolved trace elements indicates that the greatest portion of the trace elements are bound up in the suspended material.

TABLE 10

Total Recoverable vs. Dissolved Trace Elements for the Hills Ferry Site

DATE	Trace Elements (µg/L)					Dissolved				
	Total Recoverable									
	Cr	Cu	Pb	Ni	Zn	Cr	Cu	Pb	Ni	Zn
10/25/91	<1	<1	<5	<5	<1	<1	<1	<5	<5	<1
11/25/91	3.2	2	<5	6	8	<1	<1	<5	<5	<1
12/26/91	1.4	<1	<5	<5	12	<1	1.1	<5	<5	<1
1/31/92	3.5	1.5	<5	<5	3.7	<1	1.4	<5	<5	<1
3/30/92	5.1	2.7	<5	7.5	5.2	<1	1.3	<5	<5	<1
4/30/92	2.3	<1	<5	5.6	1.7	<1	<1	<5	<5	<1
5/29/92	1.8	3.5	<5	5.6	17	<1	<1	<5	<5	1.2

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Appendix

Trace Element and Mineral Data for the San Joaquin River Monitoring Sites

Site	Page
Lander Avenue (Hwy 165)	25
Fremont Ford	26
Hills Ferry Road	27
Crows Landing Road	28
Las Palmas Avenue	29
Grayson Avenue	30
Maze Boulevard	31
Airport Way	32

Table 1A. Mineral and Trace Element Water Quality Data for San Joaquin River at Lander Avenue

(site Index A, MER522) for Water Year 1992.

Location: Latitude 37° 17' 43", Longitude 120° 51' 01". In NE 1/4, NE 1/4, Sec. 27, T.7S., R.10E. East Bank,
50 W of Lander Avenue (HWY 165), 2.3 mi. S of Stevenson. River mile 132.9.

DATE	TIME	pH	EC μmhos/cm	Se μg/L	Mo μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1550	8.4	3290	0.2		0.64				84
10/7/91	915	7.8	3510	0.3		0.69				69
10/10/91	1900	7.1	3470	0.2	49	0.67				75
10/18/91	1005	7.9	3580	0.2		0.76				69
10/25/91	1155	8.2	3680	0.2	50	0.97	870	170	220	64
11/1/91	1320	7.8	100	<0.2		<0.02				59
11/8/91	1225	8.0	460	0.4	6	0.08				65
11/15/91	1315	8.1	1070	0.5	16	0.23				60
11/25/91	1000	8.5	1550	<0.2	25	0.33	270	58	110	55
12/6/91	1000	8.5	1980	<0.2	34	0.42				48
12/13/91		8.7	2130	<0.2	37	0.48				48
12/20/91	1150	8.3	2370	0.6		0.52				
12/26/91	1030	8.5	2440	0.2	44	0.51	540	96	170	48
1/2/92	1030	8.4	2530	0.3		0.58				48
1/10/92	1110	8.4	680	0.6		0.13				48
1/17/92	1000	8.6	1290	0.3		0.19				46
1/24/92	1030	8.2	1300	0.4		0.21				
1/31/92	1100	8.2	1360	0.5	13	0.25	230	88	810	48
2/7/92	1350	8.1	1475	0.4	14	0.31				56
2/14/92	1255	8.2	180	0.5	<1	0.038				56
2/21/92	950	7.9	250	0.4		0.044				59
3/6/92	945	8.5	1030	0.2		0.21				59
3/13/92	1055	8.0	975	0.3		0.19				65
3/20/92	1015	8.4	1575	0.3		0.31	260			60
3/26/92	940	8.0	1545	0.3		0.28				66
3/30/92	1000	8.2	1720	0.5	11	0.28	280	170	360	66
4/2/92	935	8.0	1700	0.2		0.26				67
4/9/92	955	8.2	1982	0.4		0.33				65
4/16/92	1030	8.3	2050	0.4		0.37				69
4/23/92	1105	8.3	1890	0.4		0.44				68
4/30/92	1410	8.4	1390	0.2	10	0.25	260	99	230	75
5/7/92	1940	8.4	1710	0.3		0.33				78
5/15/92	1258	8.3	2200	0.4		0.41				78
5/21/92	1945	8.3	2390	0.2		0.44				
5/28/92	1850	8.5	2140			0.42				81
5/29/92	1130	8.2	2170	0.3	19	0.42	380	150	340	80
6/5/92	1600	8.5	2500	0.6		0.53				85
6/12/92	1500	8.4	2770	0.6		0.62				83
6/19/92	1615	8.5	3010	0.6		0.69				83
6/26/92	1035	8.3	3070	0.3	36	0.7	720	150	230	79
7/3/92	1235	8.2	3310	0.2		0.71				78
7/10/92	1040	8.3	3360	0.4		0.72				81
7/17/92	1030	8.3	3480	0.2		0.76				82
7/24/92	950	8.6	3680	0.2		0.78				80
7/30/92	1205	8.5	3840	0.3	46	0.84	889	202	163	81
8/7/92	1115	8.6	3730	0.2		0.89				82
8/14/92	950	8.4	3870	0.2		0.89				80
8/23/92	1100	7.9	3770	0.3		0.98				71
8/28/92	1100	8.4	3770	0.2	42	0.8	878	196	160	78
9/4/92	1125	8.2	3860	0.2		0.89				74
9/11/92	1245	8.3	3770	0.1		0.96				79
9/18/92	1110	8.3	3990	0.3		0.96				74
9/25/92	1235	8.1	3850	0.2	45	0.93	919	201	210	74
Count		53	53	52	18	53	12	11	11	50
Min		7.1	100	0.1	6	0.04	230	58	110	46
Max		8.7	3990	0.6	50	0.98	919	202	810	85
Mean		8.3	2350				541	144	273	69
Geo Mean		8.3	1930				467	134	235	67
Median		8.3	2200	0.3	34	0.46	460	150	220	69

Table 2A. Mineral and Trace Element Water Quality Data for San Joaquin River at Fremont Ford (site Index B, MER538) for Water Year 1992.

Location: Latitude 37° 18' 34", Longitude 120° 55' 45". In NW 1/4, NW 1/4, Sec. 24, T.7S., R.9E. West bank at Fremont Ford State Recreation Area, 50 ft. S of HWY 140, 5.4 mi. NE of Gustine. River mile 125.2

DATE	TIME	pH	EC µmhos/cm	Se µg/L	Mn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1600	8.5	2540	2.1		1.0				82
10/7/91	925	7.7	2780	8.7		1.6				66
10/10/91	1845	8.2	2240	1.5		0.75				76
10/18/91	955	7.8	2400	1.0		0.78				66
10/25/91	1145	8.0	2870	1.1	13	1.3	600	170	540	60
11/1/91	1330	7.9	820	0.8		0.28				59
11/8/91	1240	8.0	1680	11		1.3				66
11/15/91	1325	8.1	2540	14		2.1				60
11/25/91	950	8.0	2000	4.4		1.2	300	280	400	51
12/6/91	1010	8.1	2660	3.1		1.5				43
12/13/91		8.6	2525	3.3		1.6				48
12/20/91	1140	8.3	2720	8.0		1.9				
12/26/91	1020	8.3	3080	11		2.4	520	630	660	45
1/2/92	1030	8.2	3340	13		2.8				46
1/10/92	1145	7.9	3040	17		2.8				48
1/17/92	1010	8.2	3350	15		2.9				46
1/24/92	1040	8.2	3780	17		3.1				
1/31/92	1050	8.0	3800	20		3.5	610	760	800	50
2/7/92	1345	8.0	3510	18		3.1				56
2/14/92	1245	7.8	1825	6.4		1.1				56
2/21/92	935	7.8	1215	5.1		0.93				58
2/28/92	1300	7.6	2910	16.6	11	3.1	420	640	640	64
3/6/92	955	7.9	3040	19		3.0				58
3/13/92	1105	7.8	2790	15						66
3/20/92	1020	8.0	3070	17		2.7	440			60
3/23/92	945	7.8	2185	11		1.9				62
3/26/92	950	7.7	2130	8.9		1.7				65
3/30/92	945	7.9	2480	13	10	2.3	350	580	560	63
4/2/92	950	7.9	2680	13		2.4				66
4/6/92	1030	8.0	2890	19		2.6				62
4/9/92	1005	7.9	2910	20		2.6				64
4/13/92	1005	8.1	2970	22		3.0				64
4/16/92	1045	8.1	2730	17		2.6				66
4/20/92	915	8.2	2320	16		2.2				66
4/23/92	1120	8.1	2810	16		2.5				65
4/27/92	1220	8.0	2850	15		2.2				70
4/30/92	1425	8.0	2710	18	14	2.2	430	540	610	76
5/7/92	1020	7.7	3400	14		2.4				74
5/15/92	1245	8.2	3110	11		1.8				76
5/21/92		8.6	2780	0.9		4.9				83
5/29/92	1110	8.4	3350	16	15	2.4	590	710	750	79
6/5/92	1120	8.4	3360	25		3.6				80
6/12/92	1235	8.7	2970	20		3.5				73
6/19/92	1245	9.2	2590	11		2.0				83
6/26/92	1025	7.9	1990	3.2	9	0.93	390	290	420	76
7/3/92	1250	8.4	1640	1.9		0.82				79
7/10/92	1055	8.5	2320	4.1		1.0				81
7/17/92	1045	8.3	1950	1.9		0.74				80
7/24/92	1000	8.7	1850	1.7		0.76				76
7/30/92	1130	8.4	1830	1.9	11	0.57	347	219	316	76
8/7/92	1125	8.4	2060	0.8		0.62				80
8/14/92	1000	8.3	2240	1.0		0.65				78
8/23/92	1050	8.1	1310	1.2		0.46				70
8/28/92	1050	7.6	1760	0.8	7	0.57	330	195	360	76
9/4/92	1140	7.9	2090	0.9		0.62				72
9/11/92	1300	7.8	2320	1.0		0.80				79
9/18/92	1120	8.1	2400	4.3		0.99				74
9/25/92	1245	8.3	2670	1.2	10	0.93	509	343	546	68
Count		58	58	58	9	57	13	12	12	56
Min		7.6	820	0.8	7	0.28	300	170	316	43
Max		9.2	3800	25	15	4.9	610	760	800	83
Mean		8.1	2550	9.7	11	1.9	449	446	550	67
Geo Mean		8.1	2470	6.0	11	1.6	437	393	530	66
Median		8.1	2670	11	11	1.9	430	442	553	66

Table 3A. Mineral and Trace Element Water Quality Data for San Joaquin River south of Hills Ferry Road (site Index C, STC512) for Water Year 1992.

Location: Latitude 37° 20' 33", Longitude 120° 58' 38". In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T.7S., R.9E. West bank, 0.9 mi. SE of Hills Ferry road at an abandoned tallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River mile 118.1.

DATE	TIME	pH	EC	HCO3	CO3	TALK	Ca	Mg	K	Na	TDS	Cr	Cu	Pb	Ni	Zn	Se	Mo	B	Cl	SO4	HDNS	TEMP
			µmhos/cm	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	deg F													
10/4/91	1720	8.6	2620															2.2	1.2				84
10/7/91	1100	7.8	2790															2.1	1.2				68
10/10/91	1730	8.2	2390															1.6	10	0.84			78
10/18/91	835	7.6	2150															1	0.75				61
10/25/91	1015	7.6	2540	280	<1	230	90	64	7.1	380	1600	<1	<1	<5	<5	<1	1.1	10	1.1	530	430	500	58
11/1/91	1440	7.9	880															1	0.34				59
11/8/91	1415	8.0	1500															6.7	1				67
11/15/91	1430	8.5	2360															8.8	1.8				59
11/25/91	815	7.9	2170	240	<1	200	88	52	7.6	310	1400	3.2	2	<5	6	8	5.3		1.3	310	310	450	49
12/6/91	1130	8.1	2790															4.1	1.8				47
12/13/91		8.4	2700															2.6	1.7				48
12/20/91	1020	8.2	2680															4.3	1.8				
12/26/91	1130	8.3	3150	290	<1	240	140	78	7.7	460	2000	1.4	<1	<5	<5	12	8.2		2.1	550	630	670	46
1/2/92	945	8.2	3140															8.5	2.4				46
1/10/92	1300	8.0	2400															7.8	1.9				48
1/17/92	1115	8.1	3010															8.6	2.3				46
1/24/92	1240	8.2	3325															11	2.5				
1/31/92	915	8.0	3560															3.5	1.5	<5	<5	3.7	48
2/7/92	1305	7.8	3575															14	14	2.7			55
2/14/92	1220	7.8	1925															5.1	8	1.3			56
2/21/92	915	7.7	1340															4.4	1.1				58
2/28/92	1040	7.4	2560															6.2	3.1	<5	8.8	8.7	15
3/6/92	1045	8.0	2945															13		2.7			59
3/13/92	1205	7.8	3000															13		2.3			66
3/20/92	1200	8.0	3020															11		2.3	490		60
3/23/92	1050	7.8	2410															9.6		2.1			63
3/26/92	1125	7.8	2165															6.8		1.8			68
3/30/92	805	8.0	2585	260	<1.2	210	110	59	7.2	300	1600	5.1	2.7	<5	7.5	5.2	10		2.4	340	550	570	62
4/2/92	1120	7.8	2615															9		2.3			69
4/6/92	1145	8.1	2940															12		2.6			64
4/9/92	1125	8.1	2920															14		2.5			66
4/13/92	1100	8.1	3040															17		2.9			66
4/16/92	1225	8.1	2940															14		2.6			71
4/20/92	1050	8.3	2640															13		2.3			68
4/23/92	1240	8.3	2980															13		1.5			65
4/27/92	1400	8.2	3240															15		2.2			72
4/30/92	1555	8.4	2890	250	<1.2	200	130	67	7.6	420	1800	2.3	<1	<5	5.6	1.7	15		2.3	430	550	640	74
5/7/92	835	7.7	3620															15		2.6			71
5/15/92	1124	8.1	3330															6		1.6			74
5/21/92		8.3	2630															11		1.8			73
5/29/92	950	7.9	3340	210	<1	180	130	92	8.6	500	2200	1.8	3.5	<5	5.6	17	9.3	14	1.9	650	660	720	76
6/5/92	1015	8.1	3230															16		2.8			78
6/12/92	1050	8.6	2950															19		3.2			72
6/19/92	1110	8.8	2870															17		2.5			78
6/26/92	850	8.1	2530	200	<1.2	170	100	58	7.6	330	1700	2	2	<1	4	5.9	13	13	2.1	400	530	540	74
7/3/92	1345	8.3	2250															7.2		1.7			80
7/10/92	1210	8.5	2730															6.7		1.7			82
7/17/92	1230	8.4	2470															15		2.3			86
7/24/92	1125	8.7	2630															8.8		1.9			78
7/30/92	930	7.4	2170	244	<1	244	80.5	46.5	5.4	257	1340	6	4	6	<5	21	6	10	1.4	362	359	392	72
8/7/92	1325	8.4	2410															5.1					82
8/14/92	1150	8.3	2250															3.2		1.1			80
8/23/92	935	7.9	1980															7.4		1.5			72
8/28/92	935	7.2	2010	254	<1	254	74.5	48		271	1200	<5	3	6	<5	9	3	8	1	321	279	383	72
9/4/92	1340	7.8	2230															1.2		0.9			78
9/11/92	1340	8.4	2620															14		2.6			80
9/18/92	1220	7.8	2270															1		0.92			75
9/25/92	915	7.2	2600	307	<1	307	96	66		362	1610	<5	4	6	<5	7	1.1	1	395	357	511	63	
Count		58	58	10	12	10	10	10	8	10	10	12	12	12	12	12	58	10	56	12	11	11	56
Min		7.2	880	200	<1	170	74.5	47	5.4	257	1200	<1	<1	<1	4	<1	1	5	0.34	310	279	383	46
Max		8.8	3620	307	307	140	92	8.6	500	2200	6	4	6	8.8	21	19	15	3.2	650	660	720	86	
Mean		8.0	2640	254	224	104	63	7.3	359	1650								8.7	11	1.9	428	469	535
Geo Mean		8.0	2570	251	220	102	62	7.3	351	1620								6.7	10	1.7	417	451	525
Median		8.1	2630	252	<1	220	98	62	7.6	346	1610		2	<5	<5	8	8.6	10	1.9	398	500	511	68

Table 4A. Mineral and Trace Element Water Quality Data for San Joaquin River at Crows Landing Road
(site Index D, STC504) for Water Year 1992.

Location: Latitude 37° 25' 55", Longitude 121° 00' 42", Sec. 8, T.6S., R8E. West bank, 100 yds S of Crows
Landing Road Bridge, 4.2 mi. NE of Crows Landing, River Mile 107.1

DATE	TIME	pH	EC μmhos/cm	Cr μg/L	Cu μg/L	Pb μg/L	Ni μg/L	Zn μg/L	Se μg/L	Mo μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS	TEMP deg F
10/4/91	1735	8.6	1690						2.0		0.81				82
10/7/91	1120	8.0	1310						0.8		0.45				69
10/10/91	1720	8.2	1580						1.0	5	0.49				78
10/18/91	825	7.2	1310						0.6		0.40				63
10/25/91	1000	7.7	1390	1.8	1.9	<5	<5	4.3	0.5	5	0.55	240	190	290	58
11/1/91	1510	8.1	670						0.7		0.23				59
11/8/91	1430	7.9	810						2.7	4	0.43				67
11/15/91	1445	8.7	1010						2.7	5	0.58				59
11/25/91	800	7.9	1030	3.3	1.9	<5	<5	8.0	2.8	4	0.58	140	140	210	50
12/6/91	1140	8.1	1070						1.2	4	0.48				46
12/13/91		8.4	1120						1.0	5	0.60				48
12/20/91	1005	8.1	1240						1.6		0.68				
12/26/91	830	8.1	1250						2.2	6	0.67	220	250	250	47
1/2/92	930	8.2	1280						2.9		0.83				47
1/10/92	1315	8.0	1320						4.6		0.99				48
1/17/92	1130	8.1	1450						3.9		1.1				46
1/24/92	1320	8.5	1500						3.7		0.91				
1/31/92	905	8.0	1510						4.8	5	1.0	210	240	290	47
2/7/92	1250	7.9	1535						5.4	5	1.0				53
2/14/92	1205	7.7	1045						3.2	3	0.69				54
2/21/92	845	7.7	1000						2.8		0.74				57
2/28/92	1010	7.5	1570	5.4	3.5	<5	7.1	6.5	5.5		1.2	210	290	320	60
3/6/92	1235	8.0	1710						6.4		1.3				58
3/13/92	1220	7.9	1760						6.3		1.2				66
3/20/92	1215	8.1	1855						6.4		1.3	240			60
3/23/92	1115	8.0	1566						5.7		1.2				62
3/26/92	1150	7.9	1535						5.4		1.2				64
3/30/92	745	8.0	1835	4.8	3.1	<5	7.1	4.7	7.1	6	1.6	220	360	380	64
4/2/92	1140	7.9	1760						5.8		1.4				66
4/6/92	1200	8.2	1940						7.6		1.7				
4/9/92	1140	8.0	2020						8.5		1.6				66
4/13/92	1115	8.1	2040						10		1.6				66
4/16/92	1240	8.1	1930						8.4		1.5				68
4/20/92	1100	8.2	1968						11		1.7				68
4/23/92	1250	8.2	1933						7.4		1.3				64
4/27/92	1415	8.2	2180						7.5		1.3				72
4/30/92	1610	8.4	2060	2.1	<1	<5	5	<1	9.8	10	1.4	290	380	450	72
5/7/92	815	7.9	2130						8.0		1.3				72
5/15/92	1150	8.0	1940								0.85				72
5/21/92		8.3	1480						3.3		0.83				73
5/29/92	925	8.3	1580	1.5	4.2	<5	<5	13	4.8	6	0.82	240	230	340	74
6/5/92	1000	8.3	1870						6.3		1.3				76
6/12/92	1035	8.5	2070						9.9		1.8				68
6/19/92	1040	8.5	1680						6.1		1.2				79
6/26/92	835	8.3	1630	6	9	2	12	24	6.2	5	1.2	260	310	360	74
7/3/92	1400	8.5	1740						5.1		1.2				80
7/10/92	1225	8.3	1570						2.6		0.73				79
7/17/92	1245	8.4	1600						7.1		1.2				80
7/24/92	1140	8.7	1700						5.7		1.2				75
7/30/92	905	8.3	1510	12	5	6	9	10	2.9	4	0.85	213	208	326	73
8/7/92	1345	8.4	1600						3.3						82
8/14/92	1205	8.2	1350						1.7		0.57				80
8/23/92	915	7.8	1450						6.5		1.2				72
8/28/92	915	7.7	1400	15	6	<5	6	11	2.4	3	0.67	223	193	270	71
9/4/92	1400	7.7	1410						0.8		0.53				74
9/11/92	1350	8.0	1810						2.7		1.0				79
9/18/92	1240	7.8	1480						0.9		0.61				72
9/25/92	855	7.7	1400	6	4	6	<5	9.0	0.7		0.53	198	168	323	63
Count		58	58	10	10	10	10	10	57	17	57	13	12	12	55
Min		7.2	670	1.5	<1	2	<5	4	0.5	3	0.23	140	140	210	46
Max		8.7	2180	15	9	6	12	24	11	10	1.8	290	380	450	82
Mean		8.1	1550	6					4.5	5	1.0	223	247	317	66
Geo Mean		8.1	1510	4					3.4	5	0.9	220	240	310	60
Median		8.1	1570	5.1	4	<5	6	9	4.6	5	1.0	220	240	320	67

Table 5A. Mineral and Trace Element Water Quality Data for San Joaquin River north of Patterson Bridge
 (Las Palmas Avenue, site Index E, STC507) for Water Year 1992.

Latitude 37° 29' 52", Longitude 121° 04' 54". In SW 1/4, NW 1/4, SW 1/4, Sec. 15, T.5S., R.8E. West bank, 0.3 mi. N of Patterson Bridge at NE corner of Las Palmas Launching Facility parking lot, 3.2 mi. NE of Patterson. River mile 98.6.

DATE	TIME	pH	EC μmhos/cm	Se μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1750	8.5	1540	1.3	0.64				82
10/7/91	1135	8.0	1520	0.9	0.47				70
10/10/91	1705	8.2	1680	1.5	0.48				78
10/18/91	810	7.7	1470	0.6	0.43				64
10/25/91	945	7.5	1460	0.5	0.54	250	190	290	58
11/1/91	1540	7.6	880	0.6	0.24				59
11/8/91	1440	7.8	1010	2.6	0.52				67
11/15/91	1500	8.4	1120	2.3	0.58				59
11/25/91	745	7.8	1130	2.8	0.62	160	160	230	50
12/6/91	1155	8.1	1130	0.9	0.43				47
12/13/91	1130	7.4	1205	0.8	0.59				47
12/20/91	945	8.1	1350	1.6	0.76				
12/26/91	820	8.2	1320	2.0	0.68	230	300	270	46
1/2/92	915	5.1	1360	2.8	0.86				47
1/10/92	1335	7.9	1320	3.8	1.0				49
1/17/92	1145	8.0	1540	3.9	1.1				46
1/24/92	1335	8.4	1545	3.6	0.86				
1/31/92	845	8.0	1570	4.4		210	240	290	48
2/7/92	1230	7.7	1545	4.6	1.0				56
2/14/92	1150	7.6	895	2.6	0.54				56
2/21/92	825	7.7	960	3.0	0.57				57
2/28/92	945	7.4	1600	5.5	1.2	210	200	130	61
3/6/92	1220	8.1	1660	4.9	1.2				61
3/13/92	1230	7.8	1720	5.3	1.1				67
3/20/92	1230	8.1	1855	5.5	1.3	240			61
3/26/92	1220	7.8	1515	4.7	1.2				68
3/30/92	730	7.9	1835	7.3	1.5	230	340	390	63
4/2/92	1205	7.9	1760	5.4	1.4				69
4/6/92	1205	7.9	1760	5.4	1.4				69
4/9/92	1210	8.2	1890	6.7	1.4				68
4/16/92	1255	8.1	1812	7.3	1.3				69
4/23/92	1320	8.2	1877	6.1	1.2				68
4/30/92	810	8.4	2040	8.2	1.3	310	370	460	67
5/7/92	800	7.9	2060	6.9	1.2				73
5/15/92	1035	8.2	1750	2.6	0.72				72
5/21/92		8.4	1720	3.3	0.74				71
5/29/92	900	8.4	1740	4.9	0.91	260	270	410	76
6/5/92	940	8.3	1920	4.4	1.1				76
6/12/92	1000	8.4	1760	5.1	1.1				70
6/19/92	1020	8.7	1760	5.3	1.1				80
6/26/92	815	8.3	1650	5.6	1.2	280	320	380	75
7/3/92	1420	8.7	1760	3.9	1.1				80
7/10/92	1240	8.4	1420	1.9	0.65				81
7/17/92	1305	8.7	1710	5.4	1.0				82
7/24/92	1155	8.8	1730	4.5	1.0				77
7/30/92	845	8.4	1720	2.7	0.82	267	259	357	71
8/7/92	1410	8.6	1640	3.0	0.99				84
8/14/92	1225	8.3	1370	1.6	0.58				80
8/23/92	855	7.8	1470	2.0	0.7				72
8/28/92	855	7.7	1450	2.5	0.66	229	194	406	72
9/4/92	1470	7.7	1580	1.5	0.63				76
9/11/92	1405	8.0	1550	1.2	0.89				79
9/18/92	1250	8.1	1570	0.9	0.59				74
9/25/92	835	7.7	1490	0.6	0.58	216	176	337	64
Count		54	54	54	53	13	12	12	52
Min		5.1	880	0.50	0.24	160	160	130	46
Max		8.8	2060	8.2	1.5	310	370	460	84
Mean		8.0	1550	3.5	0.88	238	252	329	67
Geo Mean		8.0	1520	2.8	0.82	235	243	314	66
Median		8.1	1570	3.2	0.86	230	250	347	69

Table 6A. Mineral and Trace Element Water Quality Data for San Joaquin River at Grayson Road, Laird Slough
 (site Index F, STC511) for Water Year 1992.

Location: Latitude 37° 33' 43", Longitude 121° 09' 03". In NW 1/4, SE 1/4, NW 1/4, Sec. 25, T.4S., R.7E.

Laird Park, 500 ft. S of Grayson Road Bridge, 1.5 mi. E of Grayson. River mile 89.1.

DATE	TIME	pH	EC μmhos/cm	Se μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1805	8.6	1540	2.2	0.62				80
10/7/91	1155	7.9	1600	1.6	0.52				70
10/10/91	1645	8.2	1580	1.6	0.44				76
10/18/91	750	7.3	1410	0.9	0.44				65
10/25/91	925	7.4	1410	0.9	0.55	230	210	320	60
11/1/91	1550	7.9	940	0.6	0.25				60
11/8/91	1505	7.7	990	2.2	0.47				66
11/15/91	1520	8.3	1160	2.4	0.57				59
11/25/91	725	8.0	1190	3.4	0.74	190	190	270	50
12/6/91	1210	7.9	1190	1.1	0.45				48
12/13/91	1150	7.6	1235	0.9	0.58				49
12/20/91	925	8.0	1420	1.7	0.74				
12/26/91	800	8.1	1400	2.3	0.71	250	270	320	47
1/2/92	850	8.1	1450	3.3	0.9				48
1/10/92	1440	7.7	1370	3.9	1.0				48
1/17/92	1200	7.8	1540	3.5	1.0				48
1/24/92	1355	8.4	1565	3.3	0.84				
1/31/92	815	8.0	1590	4.2	0.96	220	230	310	49
2/7/92	1210	7.8	1585	4.5	0.97				54
2/14/92	1120	7.4	895	2.6	0.53				56
2/21/92	750	7.7	895	2.8	0.63				57
2/28/92	920	7.4	1560	5.1	1.2	210	270	320	60
3/6/92	1435	7.7	1700	5.6	1.2				61
3/13/92	1300	7.7	1710	5.4	1.1				67
3/20/92	1250	8.0	1845	5.1	1.3	240			61
3/26/92	1245	7.8	1505	4.6	1.1				66
3/30/92	710	7.8	1780	6.3	1.4	250	340	380	63
4/2/92	1225	7.8	1770	5.8	1.3				69
4/9/92	1235	8.1	1910	6.4	1.3				68
4/16/92	1310	8.0	1780	6.9	1.2				70
4/23/92	1345	8.3	1706	5.7	0.73				68
4/30/92	835	8.2	1920	6.0	1.0	300	340	440	66
5/7/92	735	7.5	1950	7.2	1.1				72
5/15/92	945	8.1	1660	3.3	0.73				72
5/21/92		8.6	1590	3.8	0.78				71
5/29/92	810	8.5	1570	4.0	0.78	250	230	400	74
6/5/92	900	8.5	1550	4.1	0.87				77
6/12/92	935	8.6	1660	4.0	0.93				69
6/19/92	940	8.3	1530	4.2	0.87				78
6/26/92	735	8.3	1370	3.5	0.82	230	220	340	74
7/3/92	1435	9.1	1370	3.1	0.76				80
7/10/92	1300	8.2	1420	2.0	0.59				81
7/17/92	1330	8.7	1530	4.3	0.8				84
7/24/92	1220	8.9	1440	3.1	0.71				79
7/30/92	815	8.4	1640	2.9	0.73	264	230	345	72
8/7/92	1430	8.6	1420	2.8	0.68				82
8/14/92	1255	8.5	1560	2.4	0.67				80
8/23/92	830	7.8	1310	1.5	0.54				72
8/28/92	830	7.7	1370	2.6	0.65	204	172	307	72
9/4/92	1445	7.8	1280	1.0	0.42				76
9/11/92	1415	8.2	1670	1.4	0.75				79
9/18/92	1345	8.2	1530	1.3	0.57				74
9/25/92	810	7.7	1530	1.2	0.55	230	182	350	66
Count		53	53	53	13	12	12		51
Min		7.3	895	0.6	0.25	190	172	270	47
Max		9.1	1950	7.2	1.4	300	340	440	84
Mean		8.0	1490	3.3	0.79	236	240	342	67
Geo Mean		8.0	1470	2.8	0.75	234	235	339	66
Median		8.0	1530	3.3	0.74	230	230	330	68

Table 7A. Mineral and Trace Element Water Quality Data for San Joaquin River at Maze Blvd., HWY 132, (site Index G, STC510) for Water Year 1992.

Location: Latitude 37° 38' 31", Longitude 121° 13' 40". In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E. West bank, 400 ft. S of Maze Blvd. Bridge upstream of Blewett Drain, 5.7 mi NW of Grayson. River mile 77.2.

DATE	TIME	pH	EC μmhos/cm	Se μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1825	8.8	1260	1.6	0.50				78
10/7/91	1210	8.3	1380	1.2	0.51				71
10/10/91	1630	8.1	1370	1.4	0.40				74
10/18/91	735	7.4	1240	0.9	0.41				64
10/25/91	910	7.2	1010	0.6	0.46	170	130	230	59
11/1/91	1610	7.8	710	0.4	0.20				59
11/8/91	1520	7.8	800	1.3	0.31				65
11/15/91	1535	8.3	900	1.6	0.40				59
11/25/91	710	8.1	1030	2.1	0.53	150	140	220	51
12/6/91	1225	8.0	990	1.0	0.43				49
12/13/91	1215	7.8	1020	0.6	0.47				49
12/20/91	910	8.0	1130	1.3	0.56				
12/26/91	745	8.0	1090	1.7	0.53	190	180	240	48
1/2/92	825	8.1	1140	2.5	0.64				47
1/10/92	1500	7.8	1070	2.4	0.66				49
1/17/92	1215	7.9	1230	2.0	0.68				47
1/24/92	1420	8.4	1255	2.4	0.64				
1/31/92	755	8.1	1230	3.2	0.69	180	180	240	49
2/7/92	1000	7.9	1235	3.5	0.72				54
2/14/92	1100	7.6	410	1.5	0.22				54
2/21/92	730	7.7	735	2.1	0.49				57
2/28/92	850	7.5	1260	3.6	0.90	160	200	270	59
3/6/92	1500	7.8	1300	4.0	0.93				59
3/13/92	1315	7.8	1390	4.4	0.82				67
3/20/92	1315	8.0	1495	4.1	1.00	200			62
3/23/92	1230	8.0	1450	5.4	1.00				63
3/26/92	1310	7.9	1270	3.6	0.85				68
3/30/92	640	8.1	1465	4.2	1.1	170	220	310	62
4/2/92	1300	8.0	1515	4.8	1.1				70
4/6/92	1230	8.1	1500	4.4	1.1				63
4/9/92	1300	8.2	1540	4.5	1.00				69
4/13/92	1150	8.1	1500	4.4	0.95				66
4/16/92	1330	8.1	1450	5.4	0.93				71
4/20/92	1150	8.4	1186	3.7	0.77				70
4/23/92	1405	8.3	1107	3.3	0.46				67
4/27/92	1515	8.5	962	2.7	0.54				73
4/30/92	855	8.6	465	1.3	0.22	73	67	110	63
5/7/92	720	7.5	595	1.5	0.30				69
5/15/92	930	7.9	870		0.35				70
5/21/92		8.5	1320	2.3	0.61				69
5/29/92	745	8.2	1210	2.3	0.56	220	160	310	74
6/5/92	835	8.6	1380	2.5	0.74				76
6/12/92	915	8.6	1290	2.1	0.64				67
6/19/92	920	7.9	1270	2.5	0.68				74
6/26/92	715	8.0	1330	2.6	0.75	230	180	330	73
7/3/92	1445	9.0	1260	1.9	0.66				80
7/10/92	1315	8.4	1300	1.8	0.66				84
7/17/92	1345	8.7	1270	2.4	0.65				86
7/24/92	1240	9.0	1380	2.0	0.71				77
7/30/92	750	8.4	1390	1.8	0.61	230	164	297	72
8/7/92	1445	8.7	1290	2.0	0.63				83
8/14/92	1310	8.4	1280	1.6	0.55				80
8/23/92	810	7.8	1260	1.4	0.59				72
8/28/92	810	7.7	1150	1.8	0.53	180	124	245	74
9/4/92	1500	8.1	1130	0.9	0.44				77
9/11/92	1425	8.0	1100	0.8	0.50				79
9/18/92	1400	8.3	1280	1.2	0.49				76
9/25/92	740	8.4	1100	0.7	0.46	176	119	285	65
Count		58	58	57	58	13	12	12	56
Min		7.2	410	0.40	0.20	73	67	110	47
Max		9.0	1540	5.4	1.1	230	220	330	86
Mean		8.1	1180	2.4	0.62	179	155	257	66
Geo Mean		8.1	1150	2.0	0.58	173	149	249	65
Median		8.1	1260	2.1	0.61	180	162	258	68

Table 8A. Mineral and Trace Water Quality Data for San Joaquin River at Airport Way (site Index H, SJC501) for WY
 Location: Latitude 37° 40' 32", Longitude 121° 15' 51". In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E. West bank,
 S of Airport Way Bridge, 3.2 mi. NE of Vernalis. River mile 72.3

DATE	TIME	pH	EC μmhos/cm	Se μg/L	Mo μg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L	TEMP deg F
10/4/91	1835	8.9	1180	1.3		0.45				80
10/7/91	1225	8.4	1180	1.1		0.42				72
10/10/91	1615	8.3	1170	1.8	3	0.35				74
10/18/91	725	6.6	1130	0.8		0.37				64
10/25/91	850	6.9	840	0.6	2	0.34	160	110	190	59
11/1/91	1625	7.8	590	0.4		0.17				59
11/8/91	1530	7.8	700	1.0		0.26				64
11/15/91	1545	8.1	785	1.3		0.36				
11/25/91	655	8.5	880	1.7		0.41	120	100	180	50
12/6/91	1240	7.9	850	0.8		0.36				49
12/13/91	1225	7.9	870	0.4		0.40				49
12/20/91	850	8.1	1010	1.3		0.49				
12/26/91	730	8.0	1000	1.4		0.49	180	170	230	47
1/2/92	810	8.2	1060	2.2		0.55				47
1/10/92	1515	7.8	1010	1.9		0.65				49
1/17/92	1230	7.8	1130	1.7		0.62				48
1/24/92	1430	8.3	1445	2.1		0.56				
1/31/92	745	8.4	1110	2.7	5	0.62	170	150	240	48
2/7/92	700	8.1	1125	2.7		0.64				52
2/14/92	1050	8.2	410	1.5	1	0.22				54
2/21/92	710	7.5	660	2.0		0.42				57
2/28/92	825	7.3	1130	3.1		0.78	140	180	250	58
3/6/92	1515	7.8	1215	3.4		0.79				58
3/13/92	1330	7.7	1245	3.8		0.70				67
3/20/92	1325	8.0	1370	3.7		0.93	180			62
3/23/92	1250	7.8	1290	4.4		0.88				64
3/26/92	1325	7.8	1020	2.8		0.66				67
3/30/92	650	8.0	1150	3.4	4	0.77	160	200	250	62
4/2/92	1315	8.0	1135	3.5		0.78				68
4/6/92	1250	8.1	980	2.7		0.70				62
4/9/92	1320	8.2	930	2.3		0.59				66
4/13/92	1200	8.1	880	2.3		0.52				64
4/16/92	1340	8.3	823	2.7		0.48				68
4/20/92	1210	8.4	758	2.2		0.46				69
4/23/92	1420	8.4	756	2.1		0.46				66
4/27/92	1530	8.5	553	1.3		0.27				70
4/30/92	910	8.4	389	0.9		0.16	52	49	96	63
5/7/92	705	7.4	570	1.5		0.30				70
5/15/92	911	7.4	750			0.29				70
		8.5	865	2.7		0.38				69
5/29/92	730	8.1	800	1.2	2	0.35	140	93	220	71
6/5/92	815	8.6	895	1.6		0.46				76
6/12/92	900	8.4	895	1.5		0.43				67
6/19/92	850	7.5	910	3.1		0.49				75
6/26/92	700	7.8	920	1.8	1	0.50	150	120	220	71
7/3/92	1500	8.6	910	1.3		0.42				80
7/10/92	1330	8.6	980	1.3		0.45				85
7/17/92	1400	8.8	940	1.6		0.43				84
7/24/92	1255	9.2	892	1.1		0.41				79
7/30/92	730	8.5	1030	1.2	2	0.44	167	113	217	71
8/7/92	1500	8.9	965	1.1		0.44				83
8/14/92	1330	8.6	962	1.3		0.40				80
8/23/92	750	7.8	850	1.1		0.36				72
8/28/92	750	7.4	850	1.4	1	0.38	133	85.8	181	72
9/4/92	1515	8.0	965	0.7		0.34				75
9/11/92	1435	7.9	850	0.8		0.33				79
9/18/92	1415	8.4	910	0.9		0.41				76
9/25/92	720	7.6	930	0.5		0.35	122	92.9	221	66
Count		58	58	57	9	58	13	12	12	55
Min		6.6	389	0.4	1	0.16	52	49	96	47
Max		9.2	1450	4.4	5	0.93	180	200	250	85
Mean		8.1	938	1.8	2	0.47	144	122	208	66
Geo Mean		8.1	911	1.6	2	0.44	139	114	203	65
Median		8.1	925	1.5	2	0.44	150	112	220	67